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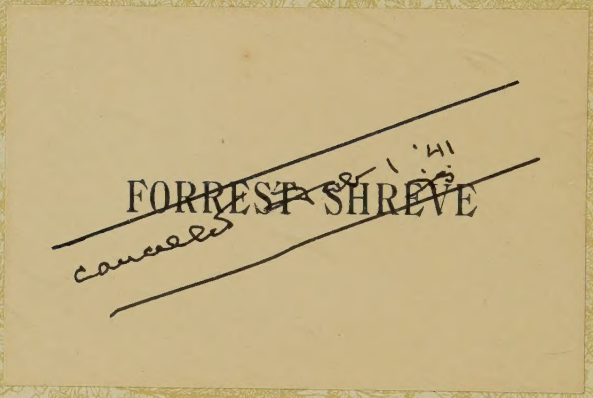
NEW ZEALAND PLANTS AND THEIR STORY.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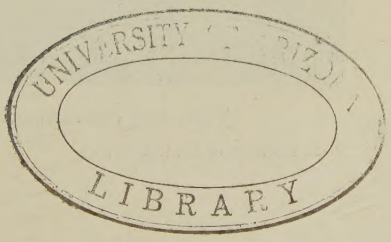
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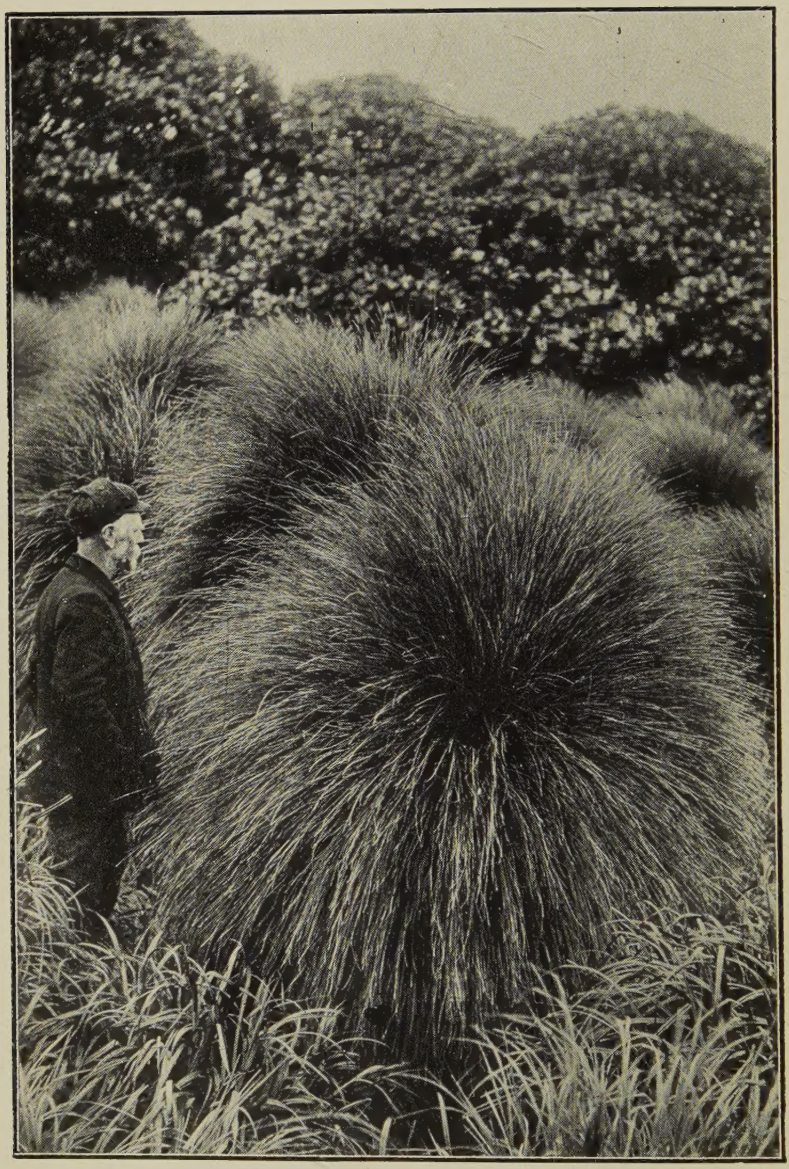

Tussock of *Poa litorosa*. Ewing Island, Auckland Islands.

Phil. Institute of Canterbury.] [Photo, S. Page.

Dr. Forest Shreve with the Author's greetings from the Antipodes.
29/12/1911

NEW ZEALAND PLANTS

AND THEIR STORY.

BY

L. COCKAYNE, PH.D., F.L.S.,

CORRESPONDING MEMBER OF THE BOTANICAL SOCIETY OF EDINBURGH.

ILLUSTRATED WITH 71 PHOTOGRAPHS.

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"The traveller, from whatever country, on arriving in New Zealand, finds himself surrounded by a vegetation that is almost wholly new to him, with little that is at first sight striking, except the Tree-fern and *Cordyline* of the northern parts, and nothing familiar, except possibly the Mangrove; and as he extends his investigations into the Flora, with the exception of *Pomaderris* and *Leptospermum*, he finds few forms that remind him of other countries."—J. D. HOOKER, "Flora Novae-Zelandiae," Vol. i; Introductory Essay; Nov., 1853.

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PREFACE.

THIS little book is based on a series of ten articles written by me for the *Lyttelton Times*, Dunedin *Evening Star*, and Auckland *Star*, which appeared during the months of April and May, 1907. To the above journals I here tender my hearty thanks for permission to reproduce those parts of the original articles that seemed suitable.

The text as it now appears has been changed in no small degree—much has been rewritten and amplified, and several additional chapters have been added, parts of two being founded on a paper I published originally in the *Young Man's Magazine;* while Chapter IX, dealing with introduced plants, is altogether new.

As for the book itself, it is the first attempt to deal with the plant-life of the New Zealand biological region as a whole on ecological lines. The subject is purposely treated in the most elementary manner; technicalities are studiously avoided as far as possible, the scientific names of the plants excepted, as the use of these is obviously unavoidable.

In the chapter dealing with the cultivation of New Zealand plants special reference is made to school gardens, for the guidance of such teachers as may use this book.

The subject-matter is, in part, the outcome of my delightful wanderings for many years over the length and breadth of the Dominion, studying the while the plants as they grow naturally; but, on the other hand, I owe much to the writings of my predecessors and

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contemporaries, especially those of Sir Joseph Hooker, F.R.S., the late Mr. T. Kirk, F.L.S., and my friend Mr. T. F. Cheeseman, F.L.S., F.Z.S.

Besides the photographs taken personally, a few were generously given by Messrs. J. Crosby-Smith, F.L.S., W. C. Davies, M. C. Gudex, M.A., F. G. Gibbs, M.A., J. J. Collins, A. Hamilton, and W. H. Field, M.P., and to these gentlemen my sincere thanks are due. I am also much indebted to Mr. W. C. Kensington, I.S.O., for permission to make use of any photographs published in my reports on botanical survey to the Department of Lands and Survey; and to the Philosophical Institute of Canterbury for the use of three photographs from the important work just issued by that body on the Subantarctic Islands of New Zealand. My friend Professor C. Chilton, M.A., D.Sc., has most generously assisted me in revising the proofs, and I thank him most sincerely.

The book is published under the auspices of the Department of Education, and I gladly take this opportunity of thanking the Hon. G. Fowlds, Minister of Education, for having arranged for the publication of the work. My thanks are likewise due to Mr. W. E. Spencer, M.A., M.Sc., of the Education Department, who has rendered valuable assistance in various ways. Finally, it gives me much pleasure to express my obligations to the Government Printer, Mr. John Mackay, and to the photographic branch of his Department.

L. C.

Christchurch, 15th August, 1910.

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CORRECTIONS.

Page 7, line 19 from top, for "puketea" read "pukatea."
„ 22, „ 2 from top, for "well" read "will."
„ 30, „ 4 from bottom, "rosy-crimson" refers to *M. diffusa*.
„ 83, „ 10 from bottom, for *Placostylis* read *Placostylus*.
„ 89, „ 15 from top, for "pink" read "purple."
„ 107, „ 2 from bottom, after "green" insert the word "bodies."
„ 120, „ 4 from bottom, and also page 170, line 9 from bottom, for *chathamica* read *chathamicum*.
„ 139, „ 7 from bottom, after "egg" add the words "within the ovule."

NEW ZEALAND PLANTS

AND THEIR STORY.

CHAPTER I.

THE GENERAL HISTORY OF THE PLANTS.

The New Zealand biological region—Special botanical interest of New Zealand—Origin of the flora—Australian and South American connections—A bridge to South America—South American worms, spiders, and fishes—South American plants—The struggle for existence—Grass land *versus* forest—The kowhai of Chatham Island—Rival theories of evolution—Plant societies.

Lying isolated from neighbouring land-masses far out in the broad Pacific, New Zealand offered conditions for plant-life different from those of most other regions. Its area, greater by far than that of any oceanic group of islands, is sufficient to have allowed the development of a rich vegetation made up of many species. The land of the "Maori and Moa," as a poet has called our land, has long been famous from both the ethnological and zoological standpoints. The remarkable race of aborigines, with their interesting manners and customs, is known far and wide. Scientific men the world over, and many of the general public, for that matter, have an acquaintance more or less intimate with the giant birds of a former age, and their fast-vanishing relatives, the kiwis of to-day.

But when it comes to the question of the plant-life there is a pause. To be sure, New Zealand is known as the land of ferns, and not without truth; yet this admired group is found nearly all the world over, and is really much less important than are plenty of the other indigenous plants. Many members of our flora, indeed, are specially noteworthy, and there is little doubt but that, as a whole, the plants

of New Zealand are every whit as interesting as are the animals, while, although less voluminous, their story can hardly be surpassed in interest by that of the vegetation of an entire continent. A plant population can surely claim its share of recognition when it can boast of including the largest known buttercup,[1] the smallest member of the pine-tree family,[2] a forget-me-not with leaves as big as those of

FIG. 1.—The Chatham Island Forget-me-not (*Myosotidium nobile*), growing near sea in north of Chatham Island. [Photo, L. Cockayne.

rhubarb[3] (fig. 1), a speedwell 40 ft. in height,[4] tree-like daisies,[5] mosses a foot or more tall,[6] brown seaweeds of enormous size[7] (fig. 2), and those strange anomalies of the plant world, the vegetable-sheep.[8]

ORIGIN OF THE FLORA.

Leaving the above-mentioned remarkable plants to be dealt with in due course, the first question which seeks an answer is how such

[1] *Ranunculus Lyallii.*
[2] *Dacrydium laxifolium.*
[3] *Myosotidium nobile.*
[4] *Veronica gigantea.*
[5] Species of *Olearia.*
[6] *Polytrichum dendroides* and *Dawsonia superba.*
[7] *Macrocystis Dubenii* and *D'Urvillea utilis.*
[8] Species of *Haastia* and *Raoulia.*

FIG. 2.—The Great Brown Seaweed (*D'Urvillea utilis*), exposed at low water. Dog Island, near Bluff.
[Photo, L. Cockayne.
Lands Department.]

a rich, peculiar, and varied assemblage of plants came together in a region so isolated as the New Zealand archipelago. This leads to a second query, as to the origin of those special plants which are found in no other land. To answer these two questions at all fully is not possible in the present state of knowledge; still, some general idea has been reached through the labours of New Zealand naturalists and others.

Let us in imagination peer into that remote past when New Zealand had finally emerged from the ocean, and when its surface, destitute of all life, was ready to receive its plant and animal immigrants.

Now, it is quite impossible to estimate geological time from figures. When we try to think of millions of years, our minds become confused; and so those long periods during which the earth gradually assumed its present form are designated by certain names representing divisions of geological time. These have been classified according to the fossils contained in the rocks. The divisions are five in number, and are named respectively, beginning with the earliest—the Archaean, the Primary, the Secondary, the Tertiary, and the Quaternary or Recent. These, again, are divided into smaller subdivisions, each, however, still of an unthinkable age.

With the first two great divisions we have nothing to do here. The history of our plants commences at that subdivision of the secondary period known as the Jurassic, when there flourished on the earth in general cycads, ferns, horse-tails, and pine-trees. The ancestors of the present crayfish and molluscs then lived in the seas, and huge reptiles wandered through the moist forests. Those plants which are propagated by means of the minute bodies known as spores—ferns and mosses, for instance—are able to travel vast distances by means of the wind, and, if the conditions are favourable, they soon gain a footing on unoccupied ground. Thus it is quite easy to account for the presence of the same species of the lower groups of plants in many lands far distant from one another. But when one comes to deal with the more highly organized seed-plants, whose seeds could travel over a vast body of water only by the merest chance, and with animals in general, many of which are still less adapted for ocean transit, speculations as to great changes having taken place on the surface of the globe come into play, and former land-connections between regions now separated by the broad ocean have to be assumed.

Without going into details, zoological and botanical statistics and evidence show clearly enough that New Zealand has received its plants from two main sources—(1) the Malay Archipelago and Australia taken together, and (2) South America, together with a problematical land-area existing in Tertiary times in the Southern Ocean, of which ice-bound Antarctica and even portions of New Zealand itself may have been parts.

According to geologists, the land-surface of New Zealand underwent great changes during Tertiary times; at one period reduced to quite a small group of islands, and at another, the land having risen hundreds of feet, stretching north, east, and south, and uniting the scattered members of the archipelago to the main islands. How far "Greater New Zealand," as it may be called, extended is a matter of conjecture, but naturalists are generally agreed that it was joined to Australia and the Malay Archipelago by way of New Caledonia and the New Hebrides. The chief matter in dispute is whether there has ever been an actual land-connection with South America.

Now, although the author has, in certain of his writings, favoured the idea of a New Zealand - South American union, there is a good deal to be said against the view, especially from the geological standpoint. Perhaps the strongest evidence that a "bridge" to South America existed lies, as Dr. W. B. Benham, F.R.S., has shown, in the presence in New Zealand of a family of South American earthworms—animals which certainly could not travel over the ocean. A spider hitherto found only on those distant granite rocks, the Bounty Islands, is allied not to any existing Australian or New Zealand species, but to a South American family. *Galaxias*, a genus of fresh-water fishes, occurs chiefly in South America and New Zealand, while there is also a species in South Africa. There is much more zoological evidence, but this will give the reader a sufficient idea as to its character.

Evidence derived from a study of plant-distribution can never by itself be regarded as conclusive, since there are various means—such as birds, ocean-currents, floating logs, icebergs, and the wind—by which seeds can be conveyed over the ocean. But the greater the distance to be traversed, the less likely are they to be carried in this manner. Heavy seeds, such as those of the kowhai, could not be blown by the wind for thousands of miles, and yet our plant of that name is identical with one growing in Chile. Our fuchsias, calceolarias, beeches, and a number of other plants have their headquarters in

South America, and must either have come thence to New Zealand, or have reached both these regions from the old problematical continent of the south.

Besides the kowhai, a number of other species are common to New Zealand and Fuegia. The following are some of the more important: *Veronica elliptica*, a shrubby speedwell, confined to the coast of the South Island, to one locality north of Cook Strait, and to the New Zealand subantarctic islands; *Crassula moschata*, a rather small succulent plant with red stems, common on many parts of the South Island coast, Stewart Island, the subantarctic islands, and Chatham Island; *Colobanthus quitensis*, a tiny plant of the pink family, occurring in some parts of the South Island mountains; *Coriaria ruscifolia*, the tutu; *Geum parviflorum*, a pretty white-flowered plant of the subalpine and alpine region; *Luzuriaga marginata* (fig. 3), a beautiful little plant, growing amongst moss in forests, and bearing a large white berry, found at sea-level in Southland, Stewart Island, and Westland, but only in subalpine forests in the North Island; two small species of rush, *Juncus scheuzerioides* and *J. novae-zelandiae;* one of the wood-rushes, *Luzula racemosa;* two sedges, *Carex Darwini* var. *urolepsis*, which up to the present has only been recorded from Chatham Island, and one of large size, *C. trifida*.

Fig. 3.—*Luzuriaga marginata*. Common to New Zealand and subantarctic South America.

[Photo, J. Crosby-Smith.

Oxalis magellanica, a pretty white wood-sorrel, occurs in New Zealand, South America, and East Australia. A number of other plants are so closely related as to be virtually common to these three regions. Finally, Macquarie Island is an interesting case, since no fewer than thirteen of its twenty-eight species of ferns and flowering-plants belong to South America or to the chain of distant subantarctic islands.

Quite recently, through the explorations of the Swedes in the first place and of Sir Ernest Shackleton in the second, it has been proved beyond doubt that forests containing both subtropical and temperate trees existed during Tertiary times in Antarctica. On Seymour Island, which is virtually a part of the antarctic continent, latitude 64° south, the Swedish Antarctic Expedition discovered a number of impressions of leaves in the sandstone rock. These have since been identified, and in some cases the species show strong relationships to plants living at the present time in South America, New Zealand, and Australia. Most interesting to us is the unlooked-for presence of a fossil *Knightia* allied to the rewarewa (*Knightia excelsa*), a tree found only in New Zealand, though there are in New Caledonia two other species of the genus, but belonging to a different section. Then, too, there is the genus *Drimys*, with the living *Drimys axillaris* (the pepper-tree), and two other New Zealand species; while *D. Winteri* (the Winter's bark) and *D. aromatica* are respectively Fuegian and Tasmanian representatives. *Laurelia*, a genus of only two species—one in Chile, and the other *L. novae-zelandiae*, the well-known puketea of the New Zealand northern forests—occurred in the forests of Tertiary Antarctica. *Araucaria braziliana*, of subtropical Brazil, and *A. Bidwillii*, of Australia, are closely related to a fossil araucaria, while the well-known monkey-puzzle tree of Chile (*A. imbricata*), the Norfolk Island pine (*A. excelsa*), and certain New Caledonian trees belong to the same genus. Other examples could be cited, but sufficient has been said to show that the remarkable discoveries of the courageous explorers strengthen the evidence in favour of land-connection between New Zealand, Australia, and South America, while the existence of an ancient antarctic vegetation, correlated, of course, with a much warmer climate, can no longer be denied.

The Struggle for Existence.

Putting on one side the question whether our plants came by land or were conveyed by winds, birds, or water, and granting that they finally got a foothold, it will be seen that soon a struggle would arise between these newcomers for the possession of the soil. Such a strife would be somewhat analogous to that which has taken place between our colonists themselves, and has resulted in riches for some and poverty for others.

Every one who cultivates a garden, however small, has to cope with what are called weeds—*i.e.*, with the plants equipped in some special manner for occupying the soil at the expense of others. A species that can rapidly reproduce itself from seed, or by suckers, creeping stems, and the like, has a great advantage over one of slower propagating-power, and will soon smother it out by force of numbers alone. Some plants have large leaves, which they flatten against the ground, and so occupy at once more than their share of the soil. Others have a peculiar taste, making them objectionable to snails, slugs, or insects, and so triumph over plants liable to the attacks of such animals. But there is no need to multiply instances; any one interested can search for examples, and a most fascinating quest it is.* The advantages in some cases are so small as not to be appreciable by us; but, however slight the benefit, the plant possessing it must conquer in the long-run.

In nature this strife between plants is always in progress—a silent but nevertheless a deadly conflict. The calm aisles of a forest are a battlefield where the trees, shrubs, and more lowly plants strive for the mastery, while at the same time the forest itself wages incessant war with the adjoining grass-land—the one or the other aided by climatic changes, an abundant rainfall favouring the forest and drier conditions the meadow. Thus, when the plant immigrants arrived from the north and from the south, these two bands of invaders from quite different regions, and not attuned to each other, would engage in fierce battle; many would fall, and those escaping would be driven into inhospitable spots.

What may be accepted as traces of such warfare are still to be encountered. For instance, the beech (*Nothofagus*) forests may be taken as typical of southern South America—of stormy Fuegia, in fact—while the ordinary New Zealand mixed forest represents, in part, one band of subtropical invaders. This latter forest is the common "bush" of New Zealand, extending from the extreme north of the region to the south of Stewart Island, and even to the distant Aucklands. But near Chelsea, a suburb of Auckland City, may be seen some New Zealand beech-trees. Other isolated groups exist farther north, and even reach that most charming spot, the Little Barrier Island. These solitary trees are doubtless remnants of a

* This matter is gone into again in Chapter IX.

battalion of the great subantarctic or antarctic plant army, held now in bondage by their northern conquerors. Farther south the beeches are more powerful; but, driven from the fertile land, they occupy the poorer soil of the lowlands or the inhospitable mountain-slopes, where they oppose a solid front to the biting blasts.

A remarkable example of the restricted distribution of a tree is shown by the kowhai of Chatham Island. This plant is common on certain volcanic ground near Auckland City. It was formerly extremely abundant in the Catlin's River forest, and in fact is found all over New Zealand, growing in various distinct kinds of soil. But in Chatham Island you may search the forest everywhere and find no trace of this graceful tree except on the limestone country near the edge of that extensive lagoon, the Whanga. There it is abundant, in company with the ordinary trees of a Chatham Island lowland forest, which latter elsewhere occupies volcanic ground. Here, then, is some slight advantage, not yet estimated by science, afforded to the ordinary trees by the volcanic soil which enables them to exclude the kowhai; whereas the limestone soil does not afford this benefit, and there all the trees meet on equal terms, flourishing side by side.

How many plants of which no trace has been found may have existed in New Zealand, and may have been destroyed through changes of conditions leading to some slight advantage for their competitors, none can tell; but that many ancient types of surpassing interest must have so perished is quite well known from such fossil plants as have been found, and amongst which, side by side with existing genera, are others not now to be found in any part of Australasia.

How Plants change their Forms.

It has been shown above how a constant warfare goes on between the plant inhabitants of the most quiescent forest or meadow, and how some survive and others perish. This truth forms the corner-stone of the doctrine of evolution. Just as there is no actual stability in the vegetation of a region, so is there none in the individual species. Constant change is the undeviating plan of nature.

The original plant-immigrants settling down in their new home would be exposed to novel conditions of soil and climate, and to contact with other plants and animals. This new environment would possibly bring about slight changes in the organisms, and in time

such small variations would so accumulate that new forms in harmony with the new conditions would arise. Such forms have arisen, and constitute, in large measure, the plants which are peculiar to New Zealand, and form nearly three-fourths of the flora so far as ferns and flowering-plants are concerned. This is stating the main facts of evolution in very general terms; no one really knows how it has come about, though no scientists deny the phenomenon. That is to say, evolution is proved up to the hilt, but its methods are still under discussion.

Three principal theories are in vogue. The first, of which Darwin and Wallace are the illustrious authors, is known as the theory of natural selection. It takes the well-known fact that all organisms vary in all directions, and considers that if certain variations are beneficial they will persist, and by degrees, in the course of an enormous number of generations, become so intensified that a new species will result. As for the unbeneficial varieties, they will in course of time perish through the conflict with the more fitted.

Quite recently the eminent Dutch botanist, Hugo de Vries, has shown, by numerous far-reaching experiments extending over many years, that certain varieties, differing markedly from the parent in some hereditary characteristics, appear all of a sudden, and that a new species comes at once into the world without the lapse of long years. If such a species is adapted to its surroundings it will remain; but, if not, it will go to the wall. This is called the mutation theory. Quite a large amount of evidence in favour of this theory is afforded by New Zealand plants, and a most interesting field of study lies in the collecting and growing varieties of variable species, and ascertaining how far such are constant and reproduce themselves "true" from seeds. *Phormium*, *Veronica*, *Epilobium*, *Celmisia*, and *Ranunculus* are genera which might with profit be studied experimentally, and which will never be properly understood otherwise.

A third school believes that the direct action of the conditions to which a plant or animal is exposed evokes changes in accord with such conditions. This is called the New Lamarckian doctrine, or the doctrine of the inheritance of acquired characters. For instance, if a plant grows in a wind-swept locality (fig. 4), according to this view, in the course of time its descendants might have the form of wind-swept plants no matter where they grow. Or if a land plant could be grown successfully in water, it might develop special structures peculiar to

Fi . .—Effect of Wind on Plant Form. In front, Manuka (*Leptospermum scoparium*), behind, *Senecio rotundifolius*. Paterson Inlet, Stewart Island.

Lands Department.] [Photo, L. Cockayne.

aquatic plants, and these would in time become hereditary. This latter theory is mentioned because a number of New Zealand species appear to afford some confirmatory evidence.

Plant Societies.

The plants having come to New Zealand, having fought many battles, and having in numerous cases given rise to new species, their final settling-down might, at the first glance, seem the work of blind chance. Yet it was nothing of the kind.

A seed falling upon any piece of ground would, if it germinated, depend for its subsistence upon its power to make the best of the circumstances. Were other better-equipped plants present, the species in question would be wiped out. Also, were its structure and organs not suitable for living under the conditions provided, it would soon vanish even were there no competition. In consequence, soil and climate exercise a selective power, and so permit various species of plants to live together under a definite set of conditions. Thus have come into being those collections of plants known as plant societies or associations,* which, taken all together, make up the vegetation of New Zealand. These societies are sometimes quite distinct in themselves, but frequently they merge into one another, just as that human society called a town merges into the adjacent farming community by way of the suburbs.

The two most important groups of plant societies are forests and grass-land. There are numerous varieties of both in New Zealand, and some of them are described further on. Another large class consists of those societies which depend upon the presence of an excess of water in the soil, as in swamps and bogs; while some plants float upon the water of streams or lakes, or are quite submerged. Others owe their presence to the very opposite set of circumstances—scarcity of water; and even in humid New Zealand something like a desert vegetation may be found in not a few places, but its presence depends rather on the nature of the soil than on an insufficient rainfall. Then there are the societies peculiar to the sea-coast, where salt in the soil and exposure to strong winds are important factors. In such places are sandhills, salt meadows and marshes, shingly or sandy beaches, and cliffs. Rocks have societies of their own, and some-

* Also called by some "plant-formations," but there is no uniformity as yet in the use of this term.

times most peculiar ones, which depend upon the nature of the rock, its steepness, its exposure with regard to wind and rain, and upon its altitude above the sea. Minor societies frequently exist within the larger ones, and, should certain changes take place, may become dominant.

From what has been said, it can be seen how important a part the study of plant societies plays in the investigation of the botany of any region. Those of New Zealand, unlike those of Europe, temperate Asia, and even much of North America, which have been modified out of all recognition through the long occupation of man, are absolutely primeval even yet in many places. But they, too, are rapidly being modified or destroyed altogether in the progress of settlement. In the temperate regions of the Old World there has been little chance of studying virgin plant societies; the science of botany began too late for such a work. It is to countries like ours that science looks for such special studies as will bring about that advance in knowledge that will shed light upon the methods by which nature planted the great garden of the world.

CHAPTER II.

HOW THE STORY HAS BEEN WRITTEN.

Sir Joseph Banks—His love of natural history—Banks and Solander in New Zealand—The first work on the New Zealand flora—Explorations by the French—Allan Cunningham and his brother—Raoul and the plants of Banks Peninsula—The work of Colenso—A novel collecting-kit—Sir Joseph Hooker and New Zealand botany—Classical works on the plant-life of New Zealand—Explorations of the Southern Alps—Hector, Buchanan, and Haast—Thomas Kirk and the modern period of New Zealand botany.

As was shown in the last chapter, if long descent counts for anything, the plants of New Zealand rank high among the aristocracy of the vegetable kingdom. On the other hand, their first historians became acquainted with them only one hundred and forty-one years ago.

Sir Joseph Banks and Dr. Daniel Charles Solander, during the month of October, 1769, found themselves in a new world, whose plant-life was all strange, and where every tree and shrub and herb was a fresh surprise and a great joy. And yet for ages before these intrepid scientists had ventured forth, and for ages, likewise, before the remote ancestors of the Maoris had completed their most perilous voyage, year by year unseen, the alpine meadows of the Southern Alps had decked themselves with a wealth of blossoms, the pohutukawas of the northern cliffs had been each summer a crimson glory, and in the swamps the lurid blooms of the flax had attracted countless bell-birds and tuis with their nectar.

Even from boyhood Banks had shown much taste for natural history. The story goes that, walking along an English lane gay with wild flowers, he exclaimed, "How beautiful! It is surely more natural that I should be taught to know all these productions of nature in preference to Latin and Greek!" From that time onwards natural science was his occupation, and during a long lifetime he devoted his wealth and energies to its advancement. Thus it was that, at his own expense, he presided over the natural-history investigations of Captain Cook's first voyage, accompanying that illustrious navigator, and taking as his colleague Dr. Solander, as well as several assistants.

Banks and Solander, whose names are always bracketed together in New Zealand botany, investigated only a comparatively few places on the coast. These were: Queen Charlotte Sound and Admiralty Bay, in the South Island; and, in the North Island, Poverty Bay, Tolaga Bay, Anaura, Mercury Bay, the Thames River (near its mouth), and the Bay of Islands. They collected in all 360 species of flowering-plants and ferns—a remarkably large collection considering the difficulties they had to encounter—a land without roads, and Natives who at any moment might prove hostile. One of their "finds" deserves a passing word. This is the beautiful shrubby groundsel (*Senecio perdicioides*), which they collected at Tolaga Bay, but of which no more specimens were gathered for more than a hundred years. But now, since its rediscovery some time ago, it has been introduced into cultivation, and may be admired in many gardens.

Banks caused about two hundred fine folio copperplate engravings to be prepared, and descriptions of more than three hundred plants were written by Solander. Plates and descriptions both are preserved in the British Museum, but, marvellous to relate, they have never been published!

The Forsters, Father and Son.

Sir Joseph Banks's explorations in the vast unknown lands of the south spurred him on to fresh exertions. He accordingly made arrangements to join Cook's second voyage, the Government of England accepting his services, as well it might. So extensive were the preparations he made that he was obliged to specially raise money to meet the expenses. He engaged, so we read, "Zoffany the painter, three draughtsmen, two secretaries, and nine servants acquainted with the modes of preserving animals and plants." The Comptroller of the Navy, however, succeeded in putting so many obstacles in Banks's way that he withdrew in disgust from the project. Notwithstanding all this, Banks, to his everlasting credit, took great interest in the voyage, and succeeded in getting Dr. John Reinhold Forster, with his son John George, appointed naturalists to the expedition.

This second voyage of Captain Cook was of special interest to the botany of New Zealand, since a portion of the real South Island vegetation was investigated for the first time, that of Queen Charlotte Sound, examined by Banks and Solander on the previous voyage,

having closer affinities with that of the North Island. A lengthy stay was made at Dusky Sound in 1773, and Queen Charlotte Sound was revisited. Only 160 ferns and flowering-plants were collected, a small gathering for a district so rich in plant-life as that including the West Coast Sounds of Otago.

The remains of Captain Cook's hut at Dusky Bay still stand, and the spot was visited by the author some years ago. There nature is exactly as it was at the time of Cook's visit. The same rich shrubbery marks the shore; kidney-ferns now, as then, clothe the forest-floor and climb up the beech and pine trees, from whose boughs, too, depend the long dark-green shoots of a drooping lycopod (*Lycopodium Billardieri*).

The elder Forster published an account of some of the plants in a work bearing the ponderous title, "Characteres Generum Plantarum quas in insulis Maris Australis collegit. J. R. Forster." This was followed by a work by the son, "Florulae Insularum Australium Prodromus," giving descriptions in Latin of 170 New Zealand plants; but these descriptions are altogether too short to be of any real use.

Menzies, D'Urville, and Richard.

In 1791, Captain Vancouver, of Arctic fame, visited Dusky Sound, and in the dripping forests Mr. A. Menzies, the surgeon of the expedition, reaped an abundant harvest of the lower plants, which there grow in the richest profusion—the mosses and liverworts. Many of these are beautifully figured in Sir W. J. Hooker's fine work, "Musci Exotici," which appeared in 1818 20. For twenty-seven years to have elapsed between the collecting and publishing of these plants speaks volumes for the leisurely methods pursued by scientific men a hundred years ago as contrasted with the haste of the present age.

And now the French come into our story, for science is cosmopolitan. In 1822, Admiral D'Urville, then an officer, but five years later captain of the same vessel, the "Astrolabe," occupied himself on the shores of Cook Strait in making collections, in company with an excellent naturalist, M. Lesson. The plants they gathered were described by A. Richard in a sterling work bearing the title, "Essay d'une Flore de la Nouvelle Zélande." So well did Richard perform his task that the book is a necessary adjunct to the library of any New Zealand botanist at the present day, especially as it clears up certain points left in doubt by the Forsters. The names of D'Urville,

Lesson, and Richard remain embalmed in the New Zealand flora in *Rapanea Urvillei*, *Pseudopanax Lessonii*, and *Polystichum Richardi*; while D'Urville Island, the French Pass, and Astrolabe Harbour tell of this important expedition.

The Cunninghams and the Plant-life of Northern Auckland.

Allan Cunningham, the colonial botanist of New South Wales, who must not be confused with his namesake the Scottish poet, visited New Zealand in 1826. The scene of his labours was the Bay of Islands and the district adjacent. Cunningham, accompanied by the Natives, spent some five months collecting plants while wandering through those virgin kauri forests, so soon to be destroyed. In 1833 his ill-fated brother Richard* proceeded to New Zealand in H.M.S. "Buffalo," presumably to assist in procuring spars for maintopmasts. This duty performed, R. Cunningham left the ship at Whangaroa, remaining alone, solely in the interests of science, according to his biographer, "on the shores of a harbour densely inhabited by savages, who had but a few years before massacred the crew of the ship 'Boyd,' and more recently had seized upon the houses and property of the Wesleyan missionaries, who, after much fatigue, privation, and insult, had effected a settlement among them." But, as luck would have it, the Maoris remembered his brother Allan, with whom they had been on most friendly terms, and so they welcomed the venturous botanist, and assisted him to the utmost of their power.

The two Cunninghams found many "new" plants—*i.e.*, such as had not been described in any publication. These, together with a description of the other known New Zealand plants, were published by Allan in his "Flora Novae-Zelandiae Praecursor; or, a Specimen of the Botany of the Islands of New Zealand"—an important work containing valuable details as to the actual stations of the plants, indispensable information so frequently not given by many authors.

Raoul and the Botany of Banks Peninsula.

The visit of the French to Akaroa in 1840, and the narrow escape from a colony of that nation being established on New Zealand soil, are matters of general history. Less well known is the fact that

* He was botanist to Mitchell's expedition to interior of New South Wales in 1835, and, getting separated from the party, was killed by the Natives.

Lands Department.] FIG 5.—*Raoulia australis*. Scoria Desert, Mount Tongariro. Photo, L. Cockayne.

accompanying the expedition was an enthusiastic botanist, Raoul by name, the surgeon of the corvette "L'Aube." He collected most assiduously the plants of Banks Peninsula, and also those of the Bay of Islands. His services to New Zealand science are kept ever green through the name of that genus of most interesting plants, *Raoulia*, (fig. 5), bestowed on them in his honour by Sir Joseph Hooker. Raoul's results were published in a splendid work, written by himself, and illustrated with fine plates, entitled "Choix de Plantes de la Nouvelle Zélande." One of the species discovered by Raoul (*Pittosporum obcordatum*) in the neighbourhood of Akaroa has never been found there since his visit, but lately a few plants have been discovered near Kaitaia, in northern Auckland.

Colenso and his Botanical Work in the North Island.

Six years before Raoul's visit, the Rev. William Colenso (fig. 6), then a young man of twenty-three, landed in the Bay of Islands, and from that time on, for a space of sixty-five years, he was a most ardent investigator in ethnology, the Maori tongue, zoology, and botany. This last alone concerns us here.

As a missionary amongst the Natives in the very early days of the colony, Colenso travelled much in the wilds, and was brought face to face with nature. He collected plants of all kinds most industriously, sending them in large quantities to Kew. Before Colenso's explorations comparatively little was known regarding the alpine vegetation, which is, indeed, in more ways than one, the most interesting of all. Enduring considerable hardships, in company with several Maoris he crossed over the Ruahine Mountains, being the first European to accomplish this feat. On the summit the alpine vegetation in all its beauty met his delighted gaze. But here are the explorer's own words: "When we emerged from the forest and the tangled shrubbery at its outskirts on to the open dell-like land just before we gained the summit, the lovely appearance of so many and varied beautiful and novel wild plants and flowers richly repaid me the toil of the journey and ascent, for never did I behold at one time in New Zealand such a profusion of Flora's stores. In one word, I was overwhelmed with astonishment, and stood looking with all my eyes, greedily devouring and drinking in the enchanting scene before me. . . . . Here were plants of the well-known genera of the bluebells and buttercups, gowans and daisies, eyebrights and speedwells of one's native land

closely intermixed with the gentians of the European Alps and the rarer southern and little-known novelties—*Drapetes*, *Ourisia*, *Cyathodes*, *Abrotanella*, and *Raoulia*."

Further on, sentiment exhausted, the naturalist sought the practical. "But how was I to carry off specimens of these precious prizes, and had I time to gather them? These mental pictures completely

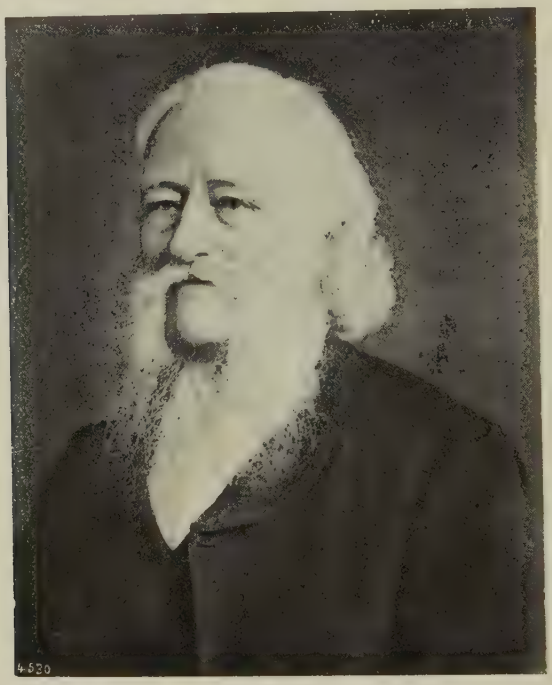

FIG. 6.—The late Rev. William Colenso.

[From a photo in the possession of A. Hamilton.

staggered me, for I realised my position well. We had left our encampment that morning, taking nothing with us, so we were all empty-handed, and no New Zealand flax grew there. However, as I had no time to lose, I first pulled off my jacket, a small travelling-coat, and made a bag of that, and then, driven by necessity, I added thereto my shirt, and by tying the neck, &c., got an excellent bag; whilst some specimens I also stowed in the crown of my hat."

Colenso's botanical writings are voluminous, and consist chiefly of papers published in the "Transactions of the New Zealand Institute," dealing with new species of plants, or what he considered to be new. Many New Zealand plants were named in his honour, including the genus *Colensoa*.

Sir Joseph Hooker and the Subantarctic Islands of New Zealand.

Sir Joseph Hooker was botanist to the famous Antarctic Expedition which left England in 1839 under the command of Sir James Ross. So far as the Dominion is concerned, Hooker visited the Auckland and Campbell Islands, and also the Bay of Islands, where he and Colenso met. He published his splendid results in several magnificent volumes, as a part of the botany of the antarctic voyage, with life-like coloured plates, under the titles "Florae Novae-Zelandiae," and "Flora Antarctica." But Hooker's work on the New Zealand flora does not end here. By an arrangement with the New Zealand Government he wrote the classical "Handbook to the New Zealand Flora," which deals not only with the flowering-plants, but with the ferns, mosses, liverworts, fungi, and seaweeds. When it is borne in mind that Hooker was compelled to work almost exclusively from dried and frequently scanty material, his results are little short of marvellous. It is true that in some cases recent research has thrown new light on his conclusions, but that does not in the least detract from the admirable accuracy of his work, which will ever remain an object-lesson for New Zealand botanists, and an edifice not to be rebuilt, but merely to be added to.

Hooker's work as a field naturalist, too, in the subantarctic islands was most thorough. Only one who has been to that region of wind and rain, and has attempted to make a botanical collection, can appreciate the completeness of his collections, and marvel at the immense amount of work accomplished in so brief a time.

The Botanical Exploration of the Southern Alps.

Between the publication of the "Flora Novae-Zelandiae" and the Handbook many important botanical explorations were undertaken in New Zealand, and the alpine flora of the South Island stood especially revealed in all its richness. This result was brought about in

large measure by the labours of Dr. A. Sinclair, R.N., Mr. J. T. Bidwell, Dr. Monro, Mr. W. T. L. Travers, Sir Julius von Haast, Sir James Hector, and Mr. J. Buchanan. Other collectors and botanists also did excellent work not only in the alpine region, but in other parts; but space forbids further details, with the exception of mentioning the work of Dr. L. Lindsay, who botanized in eastern Otago, and published a most interesting account of that district.

Dr. Sinclair collected in various parts of the North Island and in the mountains of Nelson. He was associated with Haast in an exploration of the Rangitata, but was drowned in attempting to ford that treacherous river. "Near the banks of the river, just where it emerges from the Alps, with the perpetual snowfields glistening in the sun, amidst veronicas and senecios, and covered with celmisias and gentians, there lies his lonely grave," writes Haast. Sir J. Hooker considered Sinclair as only second to Colenso as a botanical explorer, which is indeed high praise.

Mr. Bidwill's explorations began so early as 1839. He made the first collection of alpine plants in New Zealand, in what is now the Tongariro National Park, and an interesting account of his travels appears in his little book, "Rambles in New Zealand," which was published in 1841. *Forstera Bidwillii* and other plants bear his name.

The extremely interesting mountains of Nelson, whose flora differs in many respects from that of the dividing-range farther south, and has affinities with the North Island mountains, were explored, independently of one another, by Monro and Travers, and also by Bidwill, each adding considerably to our knowledge of the species of flowering-plants. The name of Monro is seen in many species of plants, and after Travers was called the genus *Traversia*, which is now, however, merged in *Senecio*.

Sir Julius von Haast first made known the alpine flora of Canterbury, and in part of Westland, which is still largely a *terra incognita*, making every use of his opportunities as Provincial Geologist. According to Hooker, he contributed more new species to the flora than any collector since Colenso. The name of a genus, *Haastia*, is a slight tribute to his exertions.

Farther south, Sir James Hector and Mr. J. Buchanan performed a large amount of careful and arduous work, and made known for the first time the botany of the Otago lake district. Buchanan also

published many observations on botanical matters, and wrote a work on the grasses of New Zealand, in which life-size figures of all the species of that family, as then known, are given. He also paid a short visit to Campbell Island.

The earlier work of Lyall must not be omitted. In 1847–49, as surgeon to the survey ship "Acheron," he collected very largely on the New Zealand coast, paying especial attention to the lower plants. It is a remarkable fact that a plant originally discovered by him, and most plentiful on the shores of Foveaux Strait, *Euphrasia repens*, is almost wanting in herbaria. The genus *Lyallia* of Kerguelen Land was founded in his honour; but to us his name is better known through the magnificent buttercup, *Ranunculus Lyallii*.

Modern New Zealand Botany and Thomas Kirk.

The publication of Hooker's Handbook brings us to what may be called the modern stage of New Zealand botany. Here the late Mr. Thomas Kirk stands foremost. For many years he held the position of leader of botanical thought in New Zealand, and was not only an industrious collector, but a prolific writer, as is proved by the 140 papers to his credit in the Transactions, so say nothing of publications elsewhere. He also wrote the "Forest Flora of New Zealand," which is the classic so far as our trees are concerned. At the time of his lamented death he was engaged on a new Flora of New Zealand, which, to the great loss of science, he did not live to complete. Fortunately, one-half was finished, and, although it lacked the correcting hand of its author, it will stand as one of the foremost publications on New Zealand floristic botany. Other workers there have been to whom New Zealand botany owes much — notably, Mr. T. F. Cheeseman, the author of the admirable "Manual of the New Zealand Flora"; and Mr. D. Petrie, who has added much to our knowledge of the plants of Otago—but most of them are still active, and their work is speaking for itself to the scientific public.

From this short sketch, which does but scant justice to the history of botanical research in New Zealand, it can be seen that our knowledge of the flora has been a thing of slow growth, and that it represents the labour of many men. Such arduous work has, for the most part, brought little, if any, pecuniary gain to its votaries, and in many cases still less recognition from their fellow-colonists, or even from

the scientific world. Some, like Sinclair and Richard Cunningham, have given their lives to the cause. All have spent much time and labour. It surely seems that these men are as worthy of the regard and admiration of their fellows as those who, in more public positions and with much blare of trumpets, serve the nation. But the naturalist gets a reward other than the plaudits of the crowd. The constant communing with nature is a source of ennobling pleasure, while the discovery of a new fact is in itself an ample recompense for all the toil of research.

CHAPTER III.

THE FORESTS.

A priceless possession—Rain-forest climate—The two classes of forests—General characteristics of the mixed forest—Origin of special forest plants—Lianes and epiphytes—Flowers—Fertilisation—New Zealand timbers—The kauri forest—The kahikatea forest—The mixed forest and its distribution—Beech forests.

However little the average New-Zealander may know about the plants of his country, few there are who cannot raise some enthusiasm regarding the "bush," as the forest is everywhere called. To old and young it is a delight—the stately trees; the birds, fearless of man; and, above all, the wealth of ferns appeal to all. But that this forest is a unique production of nature, found in no other land, is not a matter of common knowledge, though truly it has many claims to be considered a priceless possession.

According to the famous plant-geographer, Schimper, New Zealand has a rain-forest climate. That is to say, if no inhibitory conditions existed, one green mantle of trees would cover the whole land. Although this is not the case at present, it was in great part so when the early settlers arrived.

But this great forest was not all of one kind. The need of timber for house-building soon proved that various kinds of trees were more abundant in one locality than in another, and that some were wanting in one forest while plentiful elsewhere. As the trees had in many cases Maori names, the settlers soon learnt—in a rough manner, it is true—something as to the composition of the forests and their distribution. But, as some Maori names are used very loosely, accuracy was quite impossible. In this little book, therefore, although it is written for the non-botanical, the scientific names, which are definite, are used, as well as their more popular equivalents when such exist.

There are two distinct classes of New Zealand forests—viz., those consisting of many different species of trees, and those that are formed of but one kind, or nearly so. To the first category belong, with one or two exceptions, most of the lowland forests,

and to the latter the upland and subalpine beech forests and the swamp forests of kahikatea.

Let us consider first the ordinary mixed forests, the "bush" *par excellence*. These differ so considerably in their composition as really to constitute different societies, but all have much in common.

General Characteristics of the Mixed Forest.

With one or two exceptions the trees are evergreen, and consist of many species belonging to diverse families. Occasionally the bases

Fig. 7. — Base of Kahikatea (*Podocarpus dacrydioides*), showing the rounded buttresses. Ancient forest of Canterbury Plain, Riccarton.

[Photo, L. Cockayne.

of the trunks develop plank-like buttresses (fig. 7), and their uppermost roots frequently stretch over the forest-floor, half-buried, or at times raised high above the ground. Such roots and bases of the trees are closely covered with mosses and liverworts. In their interstices humus lodges, in which many ferns and seedling plants find a fitting home.

The forest is made up of different layers, if we consider the general level of the foliage. The tall trees form the uppermost layer: the

smaller trees and tallest shrubs the second; smaller shrubs, tree-ferns, and juvenile trees the third; and finally comes the forest-floor, with its carpet of mosses, liverworts, and filmy ferns, through which grow the smaller ferns and herbs. A most important feature of the forests is afforded by the climbing-plants, or lianes, as they are often called, which, rope-like, hang from the tree-tops, form an impenetrable tangle, or gracefully entwine the smaller trees and shrubs.

Tree-ferns, sometimes 20 ft. or 30 ft. in height, with enormous feathery leaves like giant umbrellas, frequently occur, often in groups

FIG. 8.—Lichens growing on the trunk of the Kamahi (*Weinmannia racemosa*). Forest of Milford Sound.

Photo, L. Cockayne.

and groves. Close-growing, small-leaved shrubs of dense habit form thickets. On tree-fern stems, on fallen trees, and even on the forest-floor are sheets of delicate filmy ferns. Lichens of great size, white or golden or dusky, abound (fig. 8). Perched high up in the forest-roof, in the forks of the branches are bird-nest-like masses, several feet in circumference, of a plant of the lily family (kahakaha, *Astelia Solandri*) (fig. 9). Long fronds of ferns and lycopods several feet in length hang drooping from the boughs, and certain orchids, with aerial roots, and

FIG. 9.—The Epiphyte, *Astelia Solandri*, growing on erect trunk of the Taraire (*Beilschmiedia tarairi*). Waipoua Kauri Forest.
[Photo, L. Cockayne.

Lands_Department.]

shrubs of various kinds, too, grow high on other trees, whose boughs thus support veritable gardens. In some few cases the flowers of a tree are produced on the thick branches, as in the kohekohe (*Dysoxylum spectabile*), and not, as usual, from amongst the leaves. Now, should a botanist knowing nothing of New Zealand read this description, he would at once conclude it was no account of the forest of a temperate climate, but of one in the tropics. And this is quite true: the common forest of New Zealand, owing partly to its origin, but far more to the moist and equable climate, must be classed with the tropical, not with the temperate forests.

Origin of Special Forest Plants.

The forest also tells us a good deal about the evolution of the wonderful adaptations of certain plants to the conditions it provides. On walking through its interior one cannot fail to notice the subdued light, which is so much less than in the open. Above all things, most plants require sunlight. Without this they cannot manufacture in their leaf laboratories their necessary food from the carbonic acid of the air. In a forest, then, there must be a struggle for the sunlight. The tall trees meet the difficulty by raising their tops high into the heavens. But with the smaller plants it is another matter, and these must either become attuned to a minimum of light, or make some special effort to get their fair share. Consequently, we find a spindling habit of growth in many young forest-trees —long, straight, thin stems, and few lateral branches; "drawn up to the light" is the gardener's phrase.

Carry out this idea a little further, and you have certain plants putting out long shoots, which, too weak to stand alone, lean against other trees for support. Go a little further still, and such long shoots develop certain organs to assist them to cling to the supporting tree. So, by slow degrees, modification after modification arises for the end in view, until the wonderful family of lianes or climbing-plants is evolved, whose roots can enjoy the cool and rich soil of the forest-floor, but whose crowns dispute with the tree-tops for the light of heaven, and under its influence bring forth their flowers, ripen their fruits, and manufacture stores of food within their green leaves.

Lianes may be conveniently divided into scramblers, root climbers, twiners, and tendril climbers, names which speak for themselves. *Fuchsia Colensoi*, a much more slender plant than the tree-fuchsia

(*F. excorticata*), offers a transition to the scrambling habit, being frequently merely a shrub, and at other times a true liane, its thin shoots being thrust amongst the branches of another tree for their support. Here there is no special differentiation of climbing-organs; but in the various species of *Rubus* it is different. On their leaf-stalks and midribs these have developed special curved hooks for climbing purposes, which grip so tenaciously whatever they touch that they have earned for these plants the sarcastic term of "lawyer." Frequently the leaf-blades are much reduced in size, and the midribs are elongated, so that the leaf is changed in function, and has become a special climbing-apparatus. In New Zealand there are several species of *Rubus*, which differ considerably in shape of leaf, size of flower, and colour of fruit, the commonest and the one with the largest leaves and most showy flowers being *R. australis*. One of the commonest root climbers, which with its leathery, green, sword-like leaves much affects the physiognomy of northern forests, is the kiekie (*Freycinetia Banksii*), whose fleshy bracts, called "tawhara" by the Maoris, are sweet and edible. The roots fasten the plant very firmly to the support, being given off at right angles or thereabouts to the stiff climbing-stem, and, passing right round the support if slender, finally put forth many rootlets, which are parallel, or nearly so, to the main roots, and close together.

The various species of climbing-ratas cling most closely when young by means of numerous short roots to the tree-trunks, their leaves more or less flattened against the bark, but finally, as the stems become cord-like, or rope-like, the roots wither away. For the different species the Maoris had the general name "aka," so scientific names here are alone available. *Metrosideros florida*, the giant of the group, has cable-like stems, sometimes 6 in. or more in diameter, covered with loose bark. It bears splendid scarlet flowers. *M. albiflora*, *M. scandens*, *M. Colensoi*, and *M. hypericifolia* have white flowers, or, in the case of the two latter, pinkish. The last-named is the most common, being found in both the main Islands and Stewart Island, growing not only on trees but also on the ground. *M. diffusa* is a strictly northern plant, as is also *M. albiflora*, which with its most beautiful rosy-crimson flowers easily takes precedence over its relations when in full bloom. With one exception the climbing-ferns are also root climbers: *e.g.*, the climbing-polypody (*Polypodium Billardieri*), whose leathery, dark-green, broad leaves, most diverse in form, are to

FIG. 10.—The Climbing Fern (*Blechnum filiforme*), showing the small early leaf-form on left and large adult leaf-form on right. Kapiti Island.

Lands Department.] [Photo, L. Cockayne.

be seen in abundance in most New Zealand forests, and the climbing hard-fern (*Blechnum filiforme*), with its two quite distinct forms of foliage-leaves on the one plant (fig. 10), and which is very common in all the drier forests of the North Island and of the lowlands of northern Nelson and Marlborough.

FIG. 11. —The Liane, the Supplejack (*Rhipogonum scandens*), growing as a member of a taxad forest.

[Photo, L. Cockayne.

The well-known supplejack (*Rhipogonum scandens*), a plant of the lily family, forms close entanglements in most lowland forests (fig. 11). Originally many of these stems have wound round young trees, which

have been strangled to death, while others have broken away from the branch to which they had clung. The two species of *Muehlenbeckia*, relatives of the common dock, are also twining-plants. They are easily recognised by their soft, green, abundant leaves, and when in fruit by the small black nuts seated on a fleshy and almost transparent cup. Very frequently, as bush boys and girls well know, their rope-like stems hang swaying from the forest-roof, the original support long vanished. *Parsonsia heterophylla*, a pretty plant producing abundance of small sweet-scented flowers, is another very common twining-liane. It occurs especially on the forest-outskirts, or where the bush has been partially cleared. It and its near relative, *P. capsularis*, may be recognised by the curious long green fruit, something like a kidney-bean in outward appearance. It is especially remarkable for the diversity of forms assumed by its leaves. These may be arranged into three series—viz., small round, long narrow, and finally moderately broad and of an oblong type. Between the small round and the long narrow are all kinds of transitional forms. One variety of the related *P. capsularis* never reaches the final adult stage, but produces flowers while in the narrow-leaved condition, and so it may perhaps be considered a fixed juvenile form of *Parsonsia heterophylla*.

The mange-mange (*Lygodium articulatum*) is a beautiful climbing-fern, whose masses of tough slender stems wound round one another make a substitute for a wire-wove mattress by no means to be despised. The leaf of an ordinary fern consists of a stalk and blade, the continuation of the former being called the midrib. The blade may be divided or undivided ; in the former case the divisions may be little leaves, each with its own stalk. In nearly all cases the leaf continues to increase in length for a certain time, when its growth is concluded. There is usually no further increase year after year. But the remarkable fern we are considering (*Lygodium*) is regulated by no such rule, for its midribs may continue to grow until the leaf is so long as to reach the tops of tall trees. The midrib thus has become a climbing organ, and a leaf many yards in length is different altogether from what one imagines a leaf to be. At regular intervals lateral leaflets, which are also capable of great extension, are given off from the midrib, one at a time, and distant from each other about 4 in., each being furnished with a very short stalk. Two quite different kinds of leaflets may be

noted—those which bear spores,* and those which function as ordinary leaves—but between the two are all kinds of transitional stages, very interesting to observe.

Those beautiful flowering-plants, the clematises, are tendril climbers, the tendrils being modified leaf-stalks. *Clematis indivisa* is the large white-flowered species; *C. hexasepala* has also white but smaller flowers; *C. Colensoi* produces masses of yellow flowers in the spring. It is especially abundant in the Wellington Province. *C. afoliata* is a curious form which looks rather like a mass of rushes. It has few or no true leaves; but they would be a harm rather than a benefit, for it grows in extremely dry places. All the New Zealand species of *Clematis* have male and female flowers on separate plants, the male being much the more showy.

The New Zealand passion-flower (*Tetrapathaea australis*) is another tendril climber. In autumn its orange or red fruits, containing numerous black seeds, are very showy. It is not found everywhere, and does not go farther south than Banks Peninsula.

All the lianes are worthy of the closest study, and not the least interesting point is to observe the differences between the climbing and non-climbing shoots. Also, it is remarkable how certain species, such as some of the lawyers and *Metrosideros scandens*, are lianes under one set of conditions and virtually shrubs under another. It is interesting, too, to grow this class of plants from seed, and to observe how the climbing habit is not shown at all, or very little, by the early seedling (fig. 12).

Another method by which plants seek the light is to boldly leave the ground and perch high on the trees. Most instructive transitions between this perching habit and the normal may be observed in any New Zealand forest. The perching-lilies (*Astelia*) (fig. 9) also grow on rocks or form huge clumps on the ground. Many ferns live indifferently either on trees or the forest-floor, as does also the lovely shrubby forest-groundsel (*Senecio Kirkii*). Certain plants are almost exclusively perchers (epiphytic). Thus *Pittosporum cornifolium* and *P. Kirkii* are of this class, and it is interesting that all the other members of the genus are ordinary terrestrial trees or shrubs. *Griselinia lucida*, with

* A spore is any single cell that becomes free from the parent plant and is capable of developing into a new individual. The spores of ferns are contained in spore-cases, and groups of these make the dots or round patches on the under-surfaces of some of the leaves of ferns.

its great leathery shining green leaves, is frequent high up in the forks of some forest giant; but it also grows on rocks near the sea, and under cultivation makes a most handsome shrub for the open border. Some of the orchids are epiphytes, and these have a special root-tissue which is quite spongy, and can absorb whatever moisture drips on to it. These perching-plants build up immense masses of

FIG. 12.—On left, Seedling of a finally much-branched Drought-resisting Shrub. On right, Seedling of a Climbing-plant.

[Photo, L. Cockayne.

soil on the tree-trunks, and it is the water-holding capacity of this which in part enables them to live under what appear such adverse circumstances. Certain ferns and lycopods are generally epiphytic — *e.g.*, the drooping-spleenwort (*Asplenium flaccidum*), the shining-leaved *Asplenium adiantoides*, and many of the filmy ferns.

Seedling trees are very common as perching-plants, or epiphytes, to use the scientific term, and some of the forest giants begin their career in this manner. These finally send down to the ground

FIG. 13.—Roots looking like climbing stems descending down trunk of a Rimu (*Dacrydium cupressinum*) coming from an epiphytic Broadleaf (*Griselinia littoralis*).

Lands Department.] [Photo, L. Cockayne.

roots which grow into a solid "root-trunk"; the former host is locked in their embrace and stifled. The northern rata (*Metrosideros robusta*), the tree-heath of the Chathams (*Dracophyllum arboreum*), and in the south the broadleaf (*Griselinia littoralis*) (fig. 13) frequently behave in this most ungrateful manner.

Though many plants are eager to get into the fresh air and sunlight, others are the reverse, and have developed different adaptations in accord with other aspirations. The interior of a thick forest has an atmosphere charged with vapour not altogether unlike that of a glasshouse. Plants living under such conditions are subject to much the same environment as submerged water-plants, and have developed similar leaves, which are so thin as to be able to absorb any water which may fall upon their surfaces. Such, amongst others, are the filmy ferns (species of *Hymenophyllum* and *Trichomanes*), the beautiful crape-fern *Todaea superba*, and its relative *Todaea hymenophylloides*. Plants like these can exist only in a moist atmosphere; the full rays of the sun or a dry atmosphere cause them to shrivel up, and they soon die when removed from their forest home. Many mosses and liverworts also belong to this category, and mimic in their forms the smaller ferns, to which, of course, they bear no relationship.

The Flowers of the Forest.

New Zealand forests are not distinguished for their brilliant flowers. On the contrary, most of our forest blossoms are inconspicuous and of a dull colour. But there are some notable exceptions. The northern and southern ratas (*Metrosideros robusta* and *M. lucida*) bear multitudes of crimson blossoms. The yellow kowhai (*Sophora grandiflora* and *S. microphylla*) has been fitly termed the New Zealand laburnum. The various species of trees known as lacebark (*Hoheria populnea*, *H. sexstylosa*, and *H. angustifolia*) are, in their season, dense masses of snowy flowers. *Pennantia corymbosa* (the kaikomako) vies in its purity with any bridal flower. The putaputaweta (*Carpodetus serratus*) is a rival of the English may. The tawiri (*Ixerba brexioides*) of the Auckland upland forest is so showy that the Maoris had a special name, "whakou," for its blooms. The tree-manuka (*Leptospermum ericoides*), with its multitude of white or pinkish flowers, quite equals the popular *Spiraea Thunbergi* of gardens.

The heketara (*Olearia Cunninghamii*) produces multitudes of daisy-like flowers in the spring. The wineberry (*Aristotelia racemosa*, mako-

mako) has distinctly pleasing rosy-coloured flowers. The hinau (*Elaeocarpus dentatus*) has numerous white drooping flowers. The large-flowered clematis (*Clematis indivisa*, puawhananga) is esteemed by all, and its snowy blossoms are frequently torn from their forest home only to wither.

The Fertilisation of the Flowers.

The methods by which flowers are fertilised are of high interest, and for the past half-century have received much attention. Space permits only a brief mention here.

The majority of flowering-plants have two special organs for purposes of fertilisation, the stamen and the pistil. The former produces a yellow "dust," the pollen; the latter contains within a little chamber* one or more little roundish or oval bodies, the ovules. Each ovule contains in its interior what may be called an "egg." If the pollen falls upon that part of the pistil termed the "stigma" at the right time, a union will eventually take place between some of the essential part of the pollen and the egg. This will lead to the formation of an embryonic plant within the ovule, which, when the embryo—*i.e.*, the little plant with seed-leaves and rudimentary root and stem—is fully developed, is termed the seed.

In some instances the stamens and pistil are close together on the same flower, and pollen and stigma are ready the one for the other at the same time, in which case the flower can fertilise itself. But in a considerable number of instances self-fertilisation is impossible, and the pollen of one flower must be applied to the stigma of another. Such cross-fertilisation, as it is called, has been proved to be beneficial for many plants. A large percentage of New Zealand trees and shrubs have the pollen-bearing flower on the one plant and the ovule-bearing on another. Others again are so constructed that the pollen is ripe before the stigma of the same flower is ready to receive it, or the stigma may in other species be developed before the pollen. In all these cases cross-fertilisation is alone possible. This may take place in two ways: either the wind may carry the pollen from one flower to another, as in the genus *Coprosma* and in many other cases,

* In the pines the ovules are not enclosed in a chamber, and there is no stigma. The pollen is conveyed by the wind and deposited on the ovules directly.

or animals may convey it dusted on some part of their bodies. In accomplishing this work, insects play a very important *rôle*. Birds also fertilise a few New Zealand plants, amongst others the puriri (*Vitex lucens*) and the waiuatua (*Rhabdothamnus Solandri*).

This action of insects in fertilising plants has led to a widely spread error in New Zealand, and one is frequently gravely informed that bees change the colours of flowers—"inoculating" is the term used. That is to say, the opinion is held that a bee sucking honey from, say, a white flower can turn it red, or blue, or yellow, as the case may be. Of course, neither a bee nor any other insect can do anything of the kind. If, however, the pollen of one flower is transferred by means of an insect, the wind, or any other agency, to the stigma of a closely related individual of a different colour, the seed which is eventually produced may give rise to a plant bearing a flower coloured differently to that of the parent plant; or, in other words, a *hybrid* has been produced. Here, then, is the source of the error in an imperfectly understood truth.

New Zealand Forest-trees as Timbers.

The forests are of great commercial importance to the Dominion. Some of the timbers are excellent for house-building, others are used as piles for bridges and sleepers on railways, and some are ornamental and can be used for furniture and general decorative work. The wood of the kauri (*Agathis australis*) is celebrated the world over, but, alas, it is rapidly being exhausted. There seems, however, every probability, according to the late Mr. H. J. Matthews, that a kauri forest from which the large trees have been cut would in time reproduce itself. With this opinion the writer, from his own observations, is quite in accord. It is unlikely, however, that such restoration would be of commercial importance, since the kauri is a tree of extremely slow growth.

At the same time, it must not be forgotten that forests, apart altogether from their timber value, are of the greatest importance to all countries because they help to conserve and regulate the water-supply—a quite different matter, however, to influencing the rainfall. Thus no forest-growth, whether primeval or secondary, should be destroyed without some strong economic reason. There are thousands of acres fit only for the natural growths now clothing them, and the destruction of these forests would be a fatal mistake.

FIG. 14.—"Gum-climber" at work on trunk of a Kauri (*Agathis australis*).

[Photo, L. Cockayne, Lands Department.]

An important by-product of the kauri is the resin, known as "gum." This is usually dug out of the ground, covered now by the northern heath, but originally occupied by kauri forest. Trees, also, have incisions made into their bark—a mischievous proceeding, the sap flowing out freely, and soon hardening into resin, which is removed finally by men who climb the trees (fig. 14).

The kahikatea (*Podocarpus dacrydioides*), the rimu (*Dacrydium cupressinum*), and the miro (*Podocarpus ferrugineus*) all afford excellent timber for various purposes, the two latter being confused in many timber-yards. The matai (*Podocarpus spicatus*) is a fine wood for resisting weather, and is only excelled by the totara (*Podocarpus totara*) and the Westland pine (*Dacrydium Colensoi*), the *D. westlandicum* of the "Forest Flora," and the yellow-pine (*D. intermedium*). These two last, also, are used largely for railway-sleepers. For fencing-posts the puriri (*Vitex lucens*), the broadleaf (*Griselinia littoralis*), and the kowhai are excellent, but the first and last become scarcer daily. It should be quite feasible to raise the kowhai artificially in any quantity, since it germinates readily from seed, and will grow very well in the open. The New Zealand honeysuckle (*Knightia excelsa*, rewarewa) is one of the handsomest woods in the world. Unfortunately, great quantities are destroyed through settlement—a destruction which should be stopped, if possible.

Other valuable timbers are: The northern rata (*Metrosideros robusta*), which is extremely hard and useful for wheelwright's work and bridge-building, as well as being an excellent firewood; the various species of *Nothofagus*, especially *N. fusca*, yielding a durable and strong building-material, which warps more or less; the pahautea (*Libocedrus Bidwillii*), a very light wood, of a red colour, out of which canoes have been made; the towai or kamahi (*Weinmannia racemosa*), yielding an excellent bark for tanning, and a wood both ornamental and strong; the pukatea (*Laurelia novae-zelandiae*), with pale-brown, soft but strong and tough wood, which has been used for boat-building and furniture; the maire-rau-nui (*Olea Cunninghamii*), an extremely strong timber.

Further details, however, are unnecessary; they may be found by those interested in Kirk's "Forest Flora," and in the admirable report of the Lands Department entitled "Forestry in New Zealand." Most of the trees have some use or other; but, as is the case

FIG. 15.—A giant Kauri, 46 ft. in circumference at 6 ft. from ground. Waipoua Kauri Forest.

Lands Department.] [Photo, L. Cockayne.

in all recently settled countries, the best timbers alone are used, and the rest go to the wall, to make room for the flocks, herds, and crops of the settler, although in many instances the forest is undoubtedly the best crop the land will ever yield.

The Kauri and Kahikatea Forests.

As stated at the beginning of this chapter, New Zealand contains many varieties of forests. Here only some of the more distinct are mentioned.

The kauri forest extends from the north of Auckland Provincial District to almost latitude 38°. It is probably the noblest tree community of temperate regions. The kauri (*Agathis australis*) (fig. 15) is not a close relation of the Old World pines, but is nearer to the monkey-puzzle family (*Araucaria*).

A kauri forest by no means consists of that tree alone, for the taraire (*Beilschmiedia tarairi*)—very handsome, with its rather large leaves, darkish-green above and bluish-white beneath—is often dominant.* The kauris form smaller or larger clumps. The kauri trees themselves are some distance apart, and the spaces between are filled up with a close growth of the huge tussocks of the kauri-grass (*Astelia trinervia*)—which, of course, is not a grass at all, but belongs to the lily family—and a sedge (*Gahnia xanthocarpa*), with leaves sharp as a razor; while growing through these are certain shrubs or small trees, especially the aromatic-leaved maireire (*Phebalium nudum*), the spiderwood (*Dracophyllum latifolium*), Kirk's groundsel (*Senecio Kirkii*), bearing in its season white daisy-like blossoms, and the silver tree-fern (*Cyathea dealbata*). Where the undergrowth is more scanty the stately kauris appear in all their grandeur, their huge grey, shining, columnar trunks rising up 60 ft. and may be 80 ft. without a branch (fig. 16), and dwarfing altogether the other trees.

High above the general forest-roof tower the great spreading branches, themselves equalling forest-trees in size. At the base of each tree is a pyramidal mound of humus caused by the shedding of the bark. Common in the kauri forest is the fantastic and irregular trunk of the rata (*Metrosideros robusta*) (fig. 17), its base covered with sheets of translucent kidney-ferns (*Trichomanes reniforme*).

* This is specially true of the northern forests. Those of the Thames and the Waitakerei Range contained much more tawa (*Beilschmiedia tawa*).

FIG. 16. Interior of portion of Waipoua Kauri Forest, where the Kauris are abundant.

Lands Department.] [Photo, L. Cockayne.

FIG. 17.—Base of a Northern Rata tree (*Metrosideros robusta*), showing its irregular form Kapiti Island.
[Photo, L. Cockayne.
Lands Department.]

Seen from without, a kauri forest is equally remarkable. The spreading heads of the kauris rise so high above the general forest-roof that it looks as if one forest were superimposed upon another. Very frequently there is found in the undergrowth a miniature tree-fern (*Blechnum Fraseri*), which has a very slender trunk 1 in. or less in diameter—not thicker, indeed, than a stout walking-stick—and rarely more than 3 ft. tall, and which spreads into large colonies by means of long slender creeping stems. *Dicksonia lanata*, too, another small tree-fern, but with a stout trunk, is frequently plentiful in some places, and may then form much of the undergrowth.

The kahikatea forest consists almost exclusively of *Podocarpus dacrydioides* — multitudes of long, straight trunks, like masts of ships, rising from the swampy ground. High up some of the stems climb the New Zealand screw-pine, the kiekie (*Freycinetia Banksii*), which also everywhere forms a rigid entanglement along the forest-floor. Dead trees bridge the ever-present pools of water, and certain shrubs, of which in the north *Coprosma tenuicaulis* is one, form more or less dense thickets.

Variation and Distribution of the Mixed Forest.

The mixed forest varies according to latitude and altitude, but a general groundwork of plants is always present. Many northern forms are wanting in the south, and, conversely, the more important southern species are less frequent in the north at a similar elevation. Latitude 38° forms a fairly definite boundary for quite a number of trees and shrubs, and latitude 42° a second boundary, though the former, and to a greater extent the latter, is overstepped in several instances.

The pines (species of *Podocarpus* and *Dacrydium*), as they are popularly called, but more correctly designated taxads, since they are related to the yew (*Taxus*), are everywhere important members of the society under discussion. Confined to the north are — the taraire (*Beilschmiedia tarairi*), the mangaeo (*Litsea calicaris*), the makamaka (*Ackama rosaefolia*), the tawhero (*Weinmannia sylvicola*), the toatoa (*Phyllocladus glaucus*), and some other trees and shrubs.

Amongst the trees not spreading much beyond latitude 42° are some very common ones of the northern forests. Some of these are—the karaka (*Corynocarpus laevigata*), which reaches Banks Peninsula; the tawa (*Beilschmiedia tawa*); the kohekohe, or New Zealand cedar

(*Dysoxylum spectabile*); the rewarewa (*Knightia excelsa*); the pukatea (*Laurelia novae-zelandiae*); the tanekaha (*Phyllocladus trichomanoides*); and some of the New Zealand olives.

The southern mixed taxad forest extending from latitude 42° to the South of Stewart Island is distinguished rather by the absence of the northern plants than by any peculiar species of its own, though such are not lacking. The Town Belt of Dunedin consists of a remnant of such a forest, and small pieces still exist all over the east of the South Island. But in the west and south the ground is still occupied by mighty forests, which for luxuriance of growth, wealth of ferns, lianes, mosses, and liverworts can hardly be surpassed. Here, too, many plants found in the North Island only in the subalpine region occur at sea-level.

The Beech Forests.

The beech forests (fig. 18), incorrectly called "birch" by the settlers, consisting of species of *Nothofagus*, are quite distinct from all those of which we have hitherto treated, although they have some species in common. The dense growth of the evergreen foliage shuts out a large percentage of light, and in consequence the undergrowth is scanty. Some South Island subalpine forests of pure mountain-beech (*N. cliffortioides*) contain in many parts little but seedling beech-trees. Woody lianes, too, are wanting,* as are the more highly organized perching-plants. Nor are ferns nearly so plentiful as in the mixed taxad forest, though one, *Polystichum vestitum*, is frequently abundant (fig. 19). The tree-trunks are frequently covered completely with a black fungus (*Antennaria*). Parasitic on the beech-trees are two mistletoes, the one, *Elytranthe tetrapetala*, having most showy scarlet flowers, and the other, *E. flavida*, having yellow flowers. A small club-moss, *Lycopodium fastigiatum*, is sometimes very abundant on the forest-floor. In moist places there are frequently large colonies of the giant moss (*Polytrichum dendroides*), looking rather like a pine-tree in miniature. Where the forest comes to an abrupt termination in the subalpine region it is invaded by some of the shrubs of that zone. At lower altitudes, and in the south of the North Island, various species of beeches and other forest-trees are mixed together, as in the Day's

* Sometimes a species of *Rubus* is present (*R. schmidelioides*, var. *coloratus*).

FIG. 18.—Gully passing through a Mountain-beech Forest (*Nothofagus cliffortioides*). Mount Torlesse, Canterbury.
[Photo, L. Cockayne.

Bay bush near Wellington; or a mixed taxad-*Nothofagus* forest such as fringes the West Coast Sounds, or is common in Nelson, may occur.

There are six species of beech in New Zealand. Elsewhere the genus occurs in the south of South America, Tasmania, and eastern Australia. Of the New Zealand species, *N. fusca* and *N. Menziesii*,

FIG. 19.—The Fern *Polystichum vestitum* at outskirts of a Mountain-beech Forest. Fronds 3 ft. in length. Base of Big Ben, Canterbury.
[Photo, L. Cockayne.

called respectively the red and silver beeches, have toothed leaves, those of the first named being thinner, larger, and of a more vivid green. It also has distinct plank-buttresses on the trunk, and is at times a tree of huge dimensions. The other species have entire leaves; but only two—the mountain-beech (*N. cliffortioides*) and the entire-leaved beech (*N. Solandri*)—are common. These two much resemble each other, except in the seedling stage.

CHAPTER IV.

THE NATURAL SHRUBBERIES.

Some peculiarities of New Zealand shrubs—The southern heath—the northern heath—Parasitic plants—The central heath—New vegetation since eruption of Tarawera—Adaptations of the heath plants—The subalpine scrub—Shrubby veronicas and daisy-trees—Contrivances of scrub plants to resist drought—Prolonged juvenile forms of New Zealand plants—Some interesting experiments—Various forms of the yellow kowhai.

New Zealand Shrubs in General.

In all gardens where a speciality is made of our native plants, it is not the trees which are there to be found, but rather the shrubs of the open country. Obviously, these latter are more easy to cultivate than forest plants. But this is not the sole reason: it is special beauty of form or flower that has marked them out as of peculiar merit. In any large garden in the world New Zealand shrubs would deservedly occupy a prominent place. Moreover, they belong, in many instances, to families which have no shrubby representatives in the Old World, whence all our ideas as to botanical form are derived.

The Germander speedwell is a pretty little creeping-plant of English lanes, with bright-blue flowers. It has many relatives in the Old Country, and in both hemispheres; but, with the exception of its New Zealand cousins, one other in Fuegia and a couple or so in Australia and Tasmania, all are herbs, or at best only woody in part. Nearly all the New Zealand speedwells are woody, and vary in habit from plants a few inches tall to forest-trees. Plants of the daisy family are usually herbaceous; but in a few regions, especially oceanic islands, shrubby forms occur, New Zealand being comparatively rich in such forms. Shrubby plants of the heath family are also frequent in our natural shrubberies, and some are of large size and quaint form.

The New Zealand shrubs, too, show some excellent examples of a certain remarkable phenomenon common amongst our plants, but much less frequent in other regions of similar size. This is the passing-through a juvenile form, during the development of the individual,

altogether distinct from the adult form, such a juvenile form frequently persisting for a considerable period of time. Many of the forest-trees have the same curious life-history; but the whole question is briefly dealt with towards the end of this chapter.

There are distinctly two kinds of natural shrubberies in New Zealand—viz., those covering extensive areas with a monotonous, uniform garb, and those occurring mainly in belts composed of many different species of shrubs. The former may be designated "heaths," the latter "scrubs."

All over New Zealand the heaths owe their physiognomy to the dominance of the manuka (*Leptospermum scoparium*), a plant belonging to the myrtle family, with slender stiff stems, small leaves, and numerous white flowers. These heaths may consist almost entirely of manuka, or other shrubs may be mixed through it. In whatever part of New Zealand it may occur, manuka heath is distinctly a sign of poor land. This shrub is of most catholic tastes. Dry ground or wet, it is all one. It may be found in swamps, knee-deep in water, in sour sphagnum bogs, on wind-swept sandhills, on the faces of dry cliffs, and even on ground impregnated with "chemicals" near boiling springs and mud-volcanoes. Besides the above species, there is also the tree-manuka, *L. ericoides*, and a species of very limited distribution, *L. Sinclairii*.

The Southern and the Northern Heaths.

In the South Island the manuka heath, so far as the shrubs go, frequently consists of pure *Leptospermum scoparium*. Sometimes other shrubs occur in varying quantities, of which *Discaria toumatou* (the wild-irishman, tumatakuru) and *Cassinia fulvida* are frequent, while *C. Vauvilliersii* is not uncommon. The ground-plants vary according to the altitude, soil, and climate. On the Bluff Hill the heath is much richer in species; and specially noteworthy are the large bushes of the mingimingi (*Styphelia acerosa*), some with abundance of white and others with pink drupes. The bracken fern (*Pteridium esculentum*) is a common constituent of heaths, and is frequently the most important plant.

Where the ground is very wet, as on the pakihis of western Nelson, the heath approximates to bog, and would be so reckoned but for the small amount of peat on the surface. The plant-covering consists of various rush-like sedges (*Cladium glomeratum*.

C. teretifolium, *C. capillaceum*), the bog umbrella-fern, a creeping club-moss, a beautiful gentian (*Gentiana Townsoni*), *Epacris pauciflora*, the very rare eyebright (*Anagosperma dispermum*), some orchids and sundews, and, of course, abundance of manuka.

In the northern part of the North Island the heath is much richer. Amongst its members are the following: A fine daisy-tree (*Olearia furfuracea*), some plants of the heath family (*e.g.*, *Styphelia fasciculata*, *Dracophyllum Urvilleanum*, *Epacris pauciflora*), a shrubby

FIG. 20.—*Pomaderris Edgerleyi*, a Heath-plant. North Cape.

Lands Department.] [Photo, L. Cockayne.

speedwell (*Veronica diosmaefolia*), the palm-lily (*Cordyline australis*), and *Coprosma rhamnoides*. Smaller shrubs are *Pomaderris elliptica* (kumarahou), *P. phylicaefolia* (tauhinu), *P. Edgerleyi* (fig. 20), and, smaller still, *Styphelia Fraseri*, a most common plant, with small pungent leaves and edible yellow "berries," which is found in various plant societies, from the sea-level to the alpine region in both Islands.

Beneath the shrubs, or in the open spaces, is a profusion of the graceful club-moss (*Lycopodium densum*). The climbing umbrella-

ferns (*Gleichenia circinata* and *G. dicarpa*) form considerable colonies. Everywhere are two rush-like plants (*Schoenus brevifolius* and *S. Tendo*) growing amongst the scrub or forming tussocks. The flat-leaved and -stemmed *Lepidosperma laterale*, another of the sedge family, is frequent in places. The dwarf cabbage-tree (ti-rauriki), (*Cordyline pumilio*), not looking a little bit like its tall relative, is abundant. Formerly its thick underground stem, incorrectly termed a root, was a favourite food of the Maoris. Careful search will reveal quite a wealth of ground-orchids, all of which are interesting, and some pretty. The climbing sundew (*Drosera auriculata*), which has pretty pink flowers, and whose tuber beneath the ground allows it to occupy a dry position, is a common plant. The iridaceous plant, turutu (*Dianella intermedia*), a plant with bright-blue berries, is very common. In the far north of the Auckland Provincial District is the curious parasitic plant, *Cassytha paniculata*, which entwines tightly other plants, and stretches its cord-like pale-coloured stems just above the surface of the ground from plant to plant, forming veritable entanglements.

C. paniculata belongs to that remarkable class of plants known as parasites. These are plants which live at the expense of others, to which they are attached. They are provided with special organs for draining the "life-blood" of their unfortunate host. Many, such as the plant in question, have little if any leaf-green, and so are quite incapable of manufacturing their food; but a number, amongst which must be numbered the New Zealand mistletoes (*Tupeia*, *Elytranthe*, &c.), are quite able to manufacture the requisite sugars, but nevertheless maintain entirely the parasitic habit. Parasites must not be confused with perching-plants (epiphytes), as is so often done. The latter are lodgers, or guests, who live on the surface of other plants, but do not draw on them for supplies.

The Central Heath of the North Island.

On the pumice-covered tableland towards the centre of the North Island the heath changes its character. Certain of the northern plants are wanting, and some peculiar to the region, or nearly so, appear. Here is that exquisite shrub, *Gaultheria oppositifolia*, with a profusion of flowers like a glorified lily of the valley. Here also is a peculiar brownish-leaved shrub of the heath family, *Dracophyllum subulatum*. Manuka is, of course, in abundance as usual.

In 1886 the eruption of Tarawera led to the burying of large areas of this plant society by volcanic ash. So thickly did this fall that in some places an actual new land-surface was formed for repopulation. This was of great interest, since opportunities for observing the settlement of a large area of virgin soil under natural conditions are rarely afforded; and in this case there is a clue to what may have taken place long ago in the evolution of the plant-covering of the adjacent country.

Where the heath was but thinly covered, it has reappeared almost in its original form; but where the covering was many feet in depth there is quite a different story. Very shortly after the eruption heavy rain occurred, and the comparatively loose soil was cut into innumerable deep but narrow gullies, with many lateral ones opening into them. The sharp ridges between these gullies are bare, but on their sides wave masses of toetoe grass (*Arundo conspicua*), a plant not very abundant in the adjacent heath. The "seeds" of this grass would, of course, be brought by the wind. Another common member of the new society is the tutu (*Coriaria ruscifolia*), its "seeds," of course, having been brought from the plants of the adjacent heath by birds.

Adaptations of the Heath Plants.

Without water, plants cannot exist. It may therefore be expected they have developed many special contrivances to insure the necessary supply. Especially important are those connected with water storage or saving, where there is danger of drought. The clay hills on which the northern heath flourishes, although soaked with water in the winter, become exceedingly dry in the summer, and had the plants no provision for husbanding their water they would die for lack of moisture.

The leaves of plants serve various purposes. On their undersurfaces usually are many most minute openings, too small by far to be seen with the naked eye, which afford communication between the interior of the leaf and the atmosphere. Through these openings a constant stream of water-vapour issues, and through them, too, a perpetual current of air enters. From the air the plant gets its oxygen for breathing, and its carbonic acid for food purposes, while the water passing away makes room within the plant for a fresh supply charged with nutritive matter drawn from the soil by the roots. If,

however, the water-vapour passes from the leaves faster than it can be replaced by the roots, the former will wilt, and in time the plant would die of thirst.

Many contrivances have been evoked to hinder this, and the form of the leaves is in part an expression of the relation of a plant to its water-supply. The heath and the subalpine-scrub plants noted below show many interesting drought-resisting contrivances. Although a leaf loses water principally through its minute pores, some may pass away from the whole leaf-surface. To hinder this the surface is specially thickened, or covered with water-resisting substances, such as wax.

Variations of leaf-form play an important part. Do away with leaves altogether and the case is met. *Carmichaelia australis*, a northern plant of the pea family, is leafless, but has green, flattened stems, which can function as leaves. The almost leafless wild-irish-man (*Discaria toumatou*) has developed rounded spines which, though they serve likewise as leaves, offer much less surface than would long green stems. The needle-like leaves of the dracophyllums not only present little surface, but they are vertical, and so never feel the full effect of the sun's rays, which together with dry air and high winds have much effect on the rapidity with which a plant loses water. *Pomaderris phylicaefolia* reduces its water-losing surface by recurving the edges of its leaves. *Olearia furfuracea* has a mat of dense hairs on the under-surface of each leaf.

The Subalpine Scrub.

In many places on the high mountains in New Zealand, especially in a part where the rainfall is excessive, upon emerging from the upper forest one is confronted with a formidable natural fence, many chains in breadth, dividing the forest from the meadow land. On certain mountains this belt is absent, or represented by stunted beech-trees or isolated patches of shrubs. The above barrier, composed of a thick and varied growth of shrubs, is designated the "subalpine scrub," and if unprovided with a track is virtually impenetrable (fig. 21). The shrubs, dense in themselves, have such wiry or rigid branches interlacing into one another that no passage can be made between them. In many places where it is impossible to crawl on one's hands and knees beneath the close mass, the only alternative is to walk upon the top.

FIG. 21.—Exterior of Subalpine Scrub of Mount Anglem, Stewart Island. The large-leaved shrub is *Olearia Colensoi ;* the shrub with erect branches raised slightly above the general level is *Dracophyllum longifolium.*

Lands Department.] [Photo, F. G. Gibbs,

At first sight it might seem that such plants would be worthless for garden purposes, and yet they are the very *élite* of the New Zealand flora. The scrubs of the montane and subalpine river-beds and terraces may also be included here.

These scrubs are the headquarters of the shrubby speedwells (*Veronica*). Here is *Veronica cupressoides*, named most fittingly, for no one seeing it for the first time and out of bloom could dream it was not a cypress. Other veronicas met with are — *V. buxifolia* var. *odora*, forming shining green bushes, round as a cricket-ball;

FIG. 22.—*Olearia macrodonta* (probably).
[Photo, J. Crosby Smith.

V. Traversii, which is of similar habit, but with much less glossy foliage; *V. glaucophylla*, with sage-green leaves; *V. subalpina*, an early-blooming species; *V. monticola*; *V. vernicosa*; and, indeed, there are dozens of species, many of which strongly resemble one another.

Daisy-shrubs (*Olearia*) are much in evidence. Common are— *O. ilicifolia* (the native holly), with musk-scented prickly crinkled leaves; *O. macrodonta*, somewhat like the above, but with broader and greener leaves (fig. 22); *O. nummularifolia* (fig. 23), with small

FIG. 23.—*Olearia nummularifolia*. Subalpine Scrub of Mount Ruapehu.

[Photo, L. Cockayne. Lands Department.]

hard and leathery leaves; *O. cymbifolia*, similar to the last-mentioned, but with the margins of the leaves much recurved; *O. moschata*, after the manner of *O. nummularifolia*, but with larger and paler-coloured leaves; *O. nitida*, with rather large, glossy leaves, covered on the under-surface with a shining mat of hairs; and *O. Colensoi*, with thick, rather large leaves, much toothed and covered beneath with a thick mat of white hairs. The remarkable *O. lacunosa*, with its leaves rather like those of a juvenile lancewood, and its relative *O. excorticata*, with broader and shorter leaves, are rarer, being confined to the Tararua Mountains in the North Island, and to the north-west and west of the South Island.

Other plants of the daisy family are the cassinias, *C. Vauvilliersii* and *C. albida*, this latter being confined to the Kaikoura and neighbouring mountains. To the same family belong also the shrubby groundsels, very common plants of the subalpine scrub, such as *Senecio elaeagnifolius*, *S. Bidwillii*, *S. cassinioides*, and *S. Monroi*.

The heaths are represented by various species of *Dracophyllum* and by *Archeria Traversii* and *Gaultheria rupestris*, the latter to be recognised by its lily-of-the-valley-like flowers, after the manner of those of *G. oppositifolia* of the central heath.

Dracophyllum Traversii is a magnificent small tree, with smooth, naked, brown stems, crowned at their extremities with rosettes of stiff, reddish leaves, having long-drawn-out points arching downwards. The subalpine flax (*Phormium Cookianum*), also a plant of sea-cliffs, is common, as is also, in some localities, one of the spear-grasses (*Aciphylla Colensoi*, var. *maxima*), a most formidable plant with bayonet-like leaves a yard long.

Little can be said here regarding the adaptations of the members of this society. Like subalpine plants the world over, their surroundings, notwithstanding an abundant rainfall, demand protection against drought. A dense, felt-like mass of hairs is frequently present on the under-surfaces of the leaves. Very leathery leaves are common, and these have a special internal structure to account for their leatheriness, which is of advantage to its possessors. Other adaptations similar to those found in the before-described heath plants are frequently present.

Prolonged Juvenile Forms of New Zealand Plants.

If the seed of *Veronica cupressoides*, or of any one of the "whip-cord veronicas," as they are aptly designated, be sown, it will quickly germinate and produce a young plant, altogether distinct from its parent. In the old plant the leaves are represented by green scales pressed closely against the stem; they are also thick, and have a peculiar anatomical structure. In the seedling, on the contrary, there are true leaves with a stalk and blade, which are quite thin and of an anatomical structure absolutely different from that of the adult. In other words, the juvenile and the adult plants might be two different species, each adapted for a quite different mode of life, the adult for an arid climate and the juvenile for a moist forest region.

If we are in a position to carry on our investigations a little further, and to grow some of the seedlings in the open air and others in a glass case so constructed as to always contain air saturated with moisture, the plant in the open will by degrees assume the adult and dry-climate habit, while the other will remain in the juvenile and wet-climate form, not for a week or two merely, but for years; indeed, so long as it is kept in a "moist chamber" it will remain a juvenile plant.

And now for a third experiment. Take a rooted cutting of an adult piece of the veronica, and place it in the moist chamber. After a few weeks its new growth will be of the juvenile form, and juvenile and adult leaves will be on the plant at the same time (fig. 24). Similar experiments with certain of the New Zealand brooms (*Carmichaelia*) and with the wild-irishman (*Discaria toumatou*) will lead to a similar result. To inquire into this matter at length would be out of place here, but any general account of New Zealand plant-life would be most incomplete without some reference to this extraordinary phenomenon. A few analogous examples may throw a little light on the subject. Many coprosmas and other shrubs belonging to diverse families* have a curious habit of growth, which makes them outwardly so similar that they are not easy to be distinguished when

* The following are some of these shrubs: The weeping-matipo (*Suttonia divaricata*). *Pittosporum rigidum*, the mountain-currant (*Aristotelia fruticosa*), the wauwaupaku (*Nothopanax anomalum*), various species of *Hymenanthera*, and *Melicytus micranthus*.

not in flower or fruit. Their branches are stiff and wiry, and interlace one with the other into a dense mass. A similar form is assumed by trees and shrubs subject to constant wind, especially if combined with a dry station.

If seed of the small-leaved kowhai (*Sophora microphylla*) be sown, a small and erect plant soon appears. But after a time this puts forth

FIG. 24.—Young Plant of *Veronica lycopodioides*, which had in part assumed the adult form with scale-leaves, putting forth true leaves in consequence of cultivation in moist air and rather feeble light. [Photo. L. Cockayne.

zigzag branches, and in a year or two a shrub of dense habit, similar to those mentioned in the last paragraph, results. But it does not remain always such a shrub, for in due course its upper part will grow into a tree, with erect branches and large leaves.

Sow the seed of *Sophora grandiflora*. Again comes the small, erect plant; but this is succeeded by no shrubby, dense form: the young plant continues its development without noticeable change until it is fully grown into a tree. Finally, sow seed of *Sophora prostrata*. Again the upright early seedling appears, then the juvenile shrubby stage, as in *S. microphylla;* but this time it never develops into a tree, but has this shrub stage as its adult form. Finally, without going into further details, there are about two hundred New Zealand plants which have adult forms differing considerably from the juvenile, many of which can, when fully grown, revert to the early form.

Now, it is held by certain biologists than an organism in its individual development passes, more or less completely, through the stages assumed by the species at various times during its past evolutionary history. If this is so, then juvenile stages represent ancestral stages, and such a plant as the seedling whipcord veronica, with leaves of the above-mentioned experiment, is the ancestor of the present river-terrace *V. cupressoides*, artificially brought back into the world, and kept so long as the moist-air treatment continues. This treatment, too, shows that the ancestral plant lived in a much moister climate than is New Zealand at the present time. The behaviour of *Sophora*, too, throws some light on the matter. The very earliest stage would be the ancestral form; but as this is the same in both *S. grandiflora* and *S. microphylla*, the former is ancestral from beginning to end of its development, whereas the latter, in its middle stage, exactly resembles *S. prostrata*.

All this points out that there came a period of drought in New Zealand, or of a climate requiring drought-resisting adaptations. Then certain adaptations against excessive dryness came into being, as in the cases of the shrubby form of *Sophora* and the adult of *Veronica cupressoides*. On a more recent change to a wetter climate some individuals of the former genus would grow out of this drought-resisting form, others would remain unchanged; but in the case of the veronica no reversion has taken place, but the "ancestral form" still remains latent.

CHAPTER V.

THE VEGETATION OF THE COAST.

General remarks—Adaptations of coastal plants—Physical and physiological dryness—Plants of sandy and rocky shores—Seaweeds—Sandhills—Reclamation of dunes—The wonderful mangrove—Coastal shrubberies—A natural post-card—The coastal veronica—Vegetation of rocks and cliffs—Salt meadows and salt marshes—Stephen Island, the home of the tuatara—The Three Kings and Poor Knights Islands.

General Remarks.

A COAST-LINE between four and five thousand miles in length, extending from nearly the latitude of Sydney in the north to far beyond that of the southernmost point of Tasmania in the south, may well furnish a great deal of diversity in both species and societies of plants. The varieties of stations for plant-life are also augmented by the physical features of the shore. In some places calm fiords, flanked by towering, precipitous mountains, stretch far inland ; in others an iron-bound coast faces the ocean storms. There are long stretches of level shore—of gravel or of sand—extensive estuaries, and tidal rivers. In short, the two main Islands, together with Stewart Island, present a diversified coast not surpassed in variety of physical features by any other of equal size.

Adaptations of Coastal Plants.

Latitude being left out of the question, in all parts of the world coastal vegetation, both in its form and distribution, depends upon certain factors. Of these, salt in the soil and exposure to sea-spray and violent winds are of prime importance. Wherever they occur, genuine seaside plants have various features in common. The most important of these are contrivances to regulate the water-supply, the commonest of which is succulence of leaf and stem, one or both. This succulence is caused by the presence of special tissues which serve for water-storage. Many New Zealand coastal plants exhibit this feature. The ice-plant (*Mesembryanthemum australe*, pig's-face, horokaka), which so frequently drapes the coastal cliffs

with its pale-green leaves, and bears rather large rose-coloured flowers, is a pleasing and familiar example (fig. 25). This species must not be confused with the Hottentot fig (*M. edule*), a native of South Africa, now naturalised on many sandhills, but which possesses leaves still "fatter" than those of its indigenous sister, and bears larger and yellow-coloured flowers. Other common coastal succulents are: *Salicornia australis* (fig. 26), a stem-succulent common in salt meadows, and *Suaeda maritima*, a leaf-succulent, usually growing in rather wetter ground.

FIG. 25.—The New Zealand Ice-plant (*Mesembrianthemum australe*), growing on rock near sea. Lyall Bay, Wellington.
[Photo, L. Cockayne.

Succulence has been shown experimentally to be brought about by excess of salt in the soil, and certain plants to which salt is not a deadly poison can be made artificially succulent. Some of the introduced plants of this country, as, *e.g.*, the spotted catchfly (*Silene anglica*, var. *quinquevulnera*), acquire much fatter leaves when growing near the sea than inland.

FIG. 26.—*Salicornia australis*, growing on rocky shore, Lyall Bay, Wellington.

Photo, L. Cockayne.

That plants growing in wet stations, such as salt meadows and marshes, should be furnished with appliances to combat drought appears very remarkable. The truth seems to be that for some reason not yet sufficiently explained, although many theories are rife, the plant dare not use too much brackish water, and so is actually in the same position as a plant of a desert region. When dealing with the bog vegetation it will be seen that it, too, is in a similar condition, and so is that in the neighbourhood of solfataras and the like.

Schimper has summed up these conditions in an excellent manner, pointing out that two kinds of dryness exist. These he has named "physical" and "physiological." Physical dryness arises from want of water in the soil, but a physiologically dry soil may contain any amount of water, but yet of such a quality that its plant inhabitants cannot use it. To quote a common example, the sea is physiologically dry, so far as man is concerned. Physiological dryness alone concerns plant-distribution.

Sandy and Rocky Shores; Seaweeds.

Sandy shores are common enough on the New Zealand coast; and as these, when sufficiently firm, are patronised as playgrounds for our children and ourselves, something as to their plants may be of interest. Such a shore may sometimes be quite without plants, except for the remains of seaweeds which mark the high-tide limit. Where the shore is sheltered, the shore convolvulus (*Calystegia Soldanella*) (fig. 27), with its lilac-striped flowers, is often present. Here, too, is the home of the tiny buttercup (*Ranunculus acaulis*), its leaves of three small succulent leaflets flat on the sand, and its little yellow flower buried right up to its neck. The New Zealand spinach (*Tetragonia expansa*), the succulent *Atriplex Billardieri*, and the prickly *Salsola Kali* are also plants of the shore.

Gravelly and rocky shores are richer in plant-life than sandy ones, since they are much more stable. On them in some places a dock (*Rumex neglectus*) is common. This has a rather stout creeping stem, which enables the plant to make considerable patches on the gravelly shore, where it grows far more luxuriantly than on the peaty ground which it also inhabits. On the stony shore of Foveaux Strait a small plant of the cress family (*Lepidium tenuicaule*) puts down an enormously long root in quest of the fresh water which flows seaward beneath the stones.

Fig. 27. The Shore Convolvulus (*Calystegia Soldanella*), growing on dune, New Brighton, Canterbury.

[Photo, A. H. Cockayne.

Where rocks jut out into the sea, forming pools, there the beautiful red seaweeds have their home; but where the sea dashes with fury, the huge brown ones are found. As two of these are so frequently cast up on the shore, they, at any rate, must be known to most who are acquainted with the seaside. The one (*Macrocystis Dubenii*) grows to an immense size, and its leaves float upon the surface of the sea by means of their small bladders full of air, while, dozens of feet below, the cord-like stems are anchored firmly to the rocky floor of the ocean. The other (*D'Urvillaea utilis*) is found in rougher water, its stouter stem showing a honeycomb-like structure when cut into. *D'Urvillaea* gets its name from the Admiral D'Urville mentioned in Chapter II. By the Stewart Island Maoris its "leaves" are made into bags for holding the preserved mutton-birds.

In the calm waters of the West Coast Sounds, where not too deep, are flower-gardens of the sea, whose loveliness can be seen for considerable depths through the transparent water. Generally speaking, the depth of water determines the distribution of seaweeds. Thus the green ones are found in the shallowest pools, and the red in the deepest, while the brown occupy a position midway, and some of these may be seen writhing like snakes over the glistening rocks at low water (fig. 2). Some seaweeds behave like the perching-plants of the forest, and have taken up their abode on other species.

Sandhills.

On many parts of the coast, sand is continually being brought on to the shore by the advancing waves. In the neighbourhood of high-water mark the shore soon becomes dry, and the sand is then borne landwards by any wind coming from the sea. Where the sand accumulates faster than it is blown away, a hill, or dune as it is frequently called, is formed. Any obstacle in the path of the blown sand will also arrest its progress and cause its heaping-up. The dunes of New Zealand are of great extent, and occupy an area of more than three hundred thousand acres. In some parts of the coast the belt of dunes is more than six miles in width, and in the north of the Auckland Province, on the west of Stewart Island, and elsewhere the sandhills attain a height of several hundred feet, though usually they are much lower.

Frequently the dunes are very unstable, and in some places so much so that great areas of moving sand exist. These "wandering

dunes" (fig. 28) insidiously advancing inland, do great damage—burying fertile fields, filling up valuable flax-swamps, choking water-courses, and overwhelming forests, plantations, pasture-lands, and even human dwellings. Happily nature has done much to stop such inroads, and the wandering dunes of New Zealand are chiefly the result of damage done by grazing animals and by burning.

In order that a plant can live on drifting sand it must have the power of binding that unstable compound into a firm mass. Plants

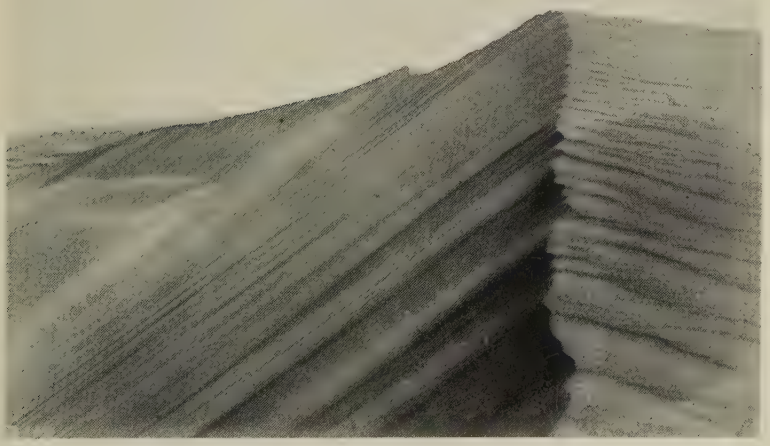

FIG. 28.—General view of a Wandering Dune occupying ground formerly good grazing-land. Dune-area of western Wellington.

Lands Department.] [Photo, L. Cockayne.

with rapidly growing underground stems, which have the power of rooting near the tips of the branches and putting forth new shoots as fast as the old ones are buried, are sand-binding plants *par excellence*. With few exceptions, wherever sandhills exist on the globe, such plants accompany them.

In New Zealand there is a most excellent example in the pingao (*Scirpus frondosus*) (fig. 29). Its thick, rope-like stems, commonly called roots, form a perfect entanglement inside the dune, and its

semi-tussocks of stiff, golden-coloured leaves crown many sandhills from the North Cape to the Bluff. Unfortunately, rabbits and some other animals do not despise this plant, notwithstanding its most unappetising-looking leaves. In consequence, they destroy this natural protector of our shores, which came into being in a land where grazing animals, the moa excepted, were unknown, and so developed no protective adaptations.

The spiny rolling-grass (*Spinifex hirsutus*), a native of Australia also, is another very important indigenous sand-binder. Its stout

FIG. 29.—Breach in Foredune made by Sea, north of Rangitikei River. The Pingao (*Scirpus frondosus*) on right.
Lands Department.] [Photo, L. Cockayne.

stems, often many feet in length, at first creep over the surface of the sand, firmly fixing themselves by means of many roots. Finally they are buried, and the tufts of long flexible leaves, covered densely with soft silvery hairs, project out of the sand. The pollen-bearing and ovule-bearing plants are distinct. When the seeds are ripe, the mature inflorescence breaks off, and, borne by the wind, hops on its long spines over the sandy shore like some huge insect, until, at

last falling to pieces, the "seeds" are deposited and finally buried. *S. hirsutus* naturally builds up fairly stable dunes which in some places have a surface so even as to look like a railway-embankment (fig. 30), as in the case of the dune fronting the shore near Waikanae, in the Wellington Province.

In Europe, America, and elsewhere plants and grazing animals assumed their present forms side by side. The marram-grass of Europe (*Ammophila arenaria*) is a case in point. This, although naturally

FIG. 30.—Natural and even Foredune built by Wind and the Silvery Sand-grass (*Spinifex hirsutus*). Coast near Waikanae.

Lands Department.] [Photo, W. H. Field.

little better as a sand-binder than our *Scirpus* or *Spinifex*, is of infinitely more value for "reclaiming" our moving sands, since it is not relished as food, and grows rapidly and luxuriantly. With the marram may be used the lyme-grass (*Elymus arenarius*), another European sand-binder.

Besides grasses, trees and shrubs are of great service for sand-fixing. Of the latter, the tree-lupin of California (*Lupinus arboreus*) is a

most valuable plant when used with discretion. But the question of dune-fixing is too complex for discussion here, and, so far as New Zealand goes, the matter is still quite in its infancy.

Where the dunes are more stable, other special "sand-plants" are common. Of these, *Coprosma acerosa* (fig. 31), with wiry, reddish-coloured, interlacing twigs, is found everywhere; and so, too, is *Pimelia arenaria*, a low-spreading shrub, with pretty silvery leaves and white flowers. Certain species of *Cassinia*, which belongs to the

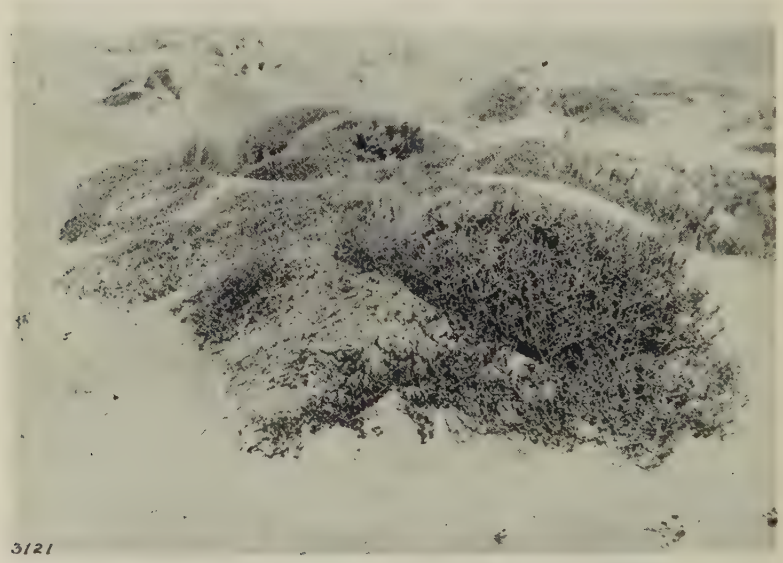

FIG. 31.—The Sand-coprosma (*Coprosma acerosa*) building a Temporary Dune. Coast of Canterbury.

Lands Department.] [Photo, L. Cockayne.

daisy family, are very frequent features of this society, but they are different in various parts of the Dominion. In the Auckland region it is *Cassinia retorta*; Taranaki, Hawke's Bay, and the shores of Cook Strait have the tauhinu or cottonwood (*C. leptophylla*); while farther south the yellow-leaved *C. fulvida* is the sole representative until the Bluff Hill or certain places on the east of Otago are reached, when *C. Vauvilliersii*, a common subalpine shrub, puts in an appearance.

Where the force of the wind is less felt, a heath may make its appearance, and the manuka (*Leptospermum scoparium*), the cabbage-tree (*Cordyline australis*), the toetoe (*Arundo conspicua*), the flax (*Phormium tenax*), and, from the shores of Cook Strait southwards, the wild-irishman (*Discaria toumatou*) occur in force (fig. 32).

Hollows in the dune region are very frequent, the sand being blown away until the ground-water is almost reached. Where the water cannot get away there will be swamps and even shallow lakes.

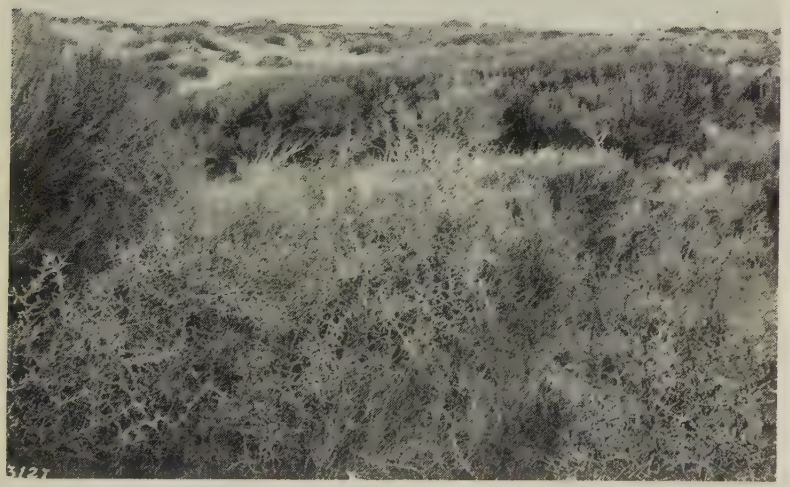

FIG. 32.—Heath of Sand-plain. In front, the Wild-irishman (*Discaria toumatou*).

Lands Department.] [Photo, L. Cockayne.

In sandy hollows the pioneer plant is a creeping-sedge (*Carex pumila*), which soon builds miniature dunes. The sand-gunnera (*Gunnera arenaria*), forming close mats of small pale-green leaves flattened to the ground, is also very abundant in many localities. Such hollows finally become occupied by introduced grasses and plants of the clover family, and these render the dune region of economic importance, though the grazing by sheep and cattle leads in time to instability of the nature-fixed hills and to the filling-up of the hollows.

The Mangrove.

Let us leave the dunes, and, in imagination, sail up one of those wide estuaries in the west of the Auckland Province—Hokianga or Kaipara Harbour, or one of the tidal rivers of the east—the Whangarei, for instance. If it is high tide, we shall see on either side of the stream a belt of close-growing, dull-coloured, small trees, rising out of the turbid water. These consist of the mangrove (*Avicennia officinalis*), and the sight is one almost unknown in any other land outside the tropics. It is, in fact, one of the natural wonders of New Zealand.

Now, quite undeservedly, the mangrove has got a bad reputation. A mangrove swamp is supposed to represent all that is most hideous on earth—alligators in crowds, a fearsome odour, crabs waiting to pick such of the victim's bones as are left by the alligators, malaria, and deadly microbes in vast abundance. Even in the tropics this picture has been shown to be absurd, and in New Zealand the mangrove belt is quite a pleasing feature of the northern rivers. It is also a most beneficial plant, as it materially assists in turning muddy useless shores into good dry land.

Moreover, the mangrove is one of the most noteworthy plants in nature. As our boat proceeds up the river the tide has turned, and the slimy flats, where the mangrove is rooted, come into view. There, projecting out of the mud, are thousands of upright bodies, 6 in. or so in length, looking much like stout asparagus-shoots. One might feel sure these were young mangroves. But they are nothing of the sort, strange as it may seem. They are roots, which, instead of passing downwards to anchor the trees, grow upwards into the air. On being examined, they are found to consist largely of a very porous tissue. Plants, like animals, cannot live without oxygen. They need to breathe just as much as we human beings do ; without air they would die of suffocation. In the soft mud is little of the life-giving gas, hence the necessity for the mangrove to obtain a supply for its ordinary roots. This it does with these erect organs, which are the veritable lungs of the tree. Of course, the aerial parts of the mangrove, like those of any other tree, procure oxygen by means of the small pores in the leaves and minute openings in their bark.

The mangrove, too, has another peculiarity of even greater interest than that just described. If a seed were to fall on the muddy floor of a tidal estuary, being washed hither and thither by the ebb and

Fig. 33.—The Round-leaved Shrubby Groundsel (*Senecio rotundifolius*). Shore of Paterson Inlet, Stewart Island.
[Photo, L. Cockayne.
Lands Department.]

flow of the tide, it would have little chance of germinating. Consequently, the embryos in the seeds of the mangrove develop considerably while still on the tree, emerging from the seed and producing rudiments of roots ready for rapid growth. When such young plants fall from the tree, the roots grow rapidly. They pass downwards and outwards from near the tip of the stem below the seed-leaves, and so anchor the plantlet firmly in the unstable ground. Nor is this all. The seed-leaves are fleshy and full of nourishment, and on this the young mangrove lives in part* until the time when, provided with foliage, it is in a position to manufacture for itself the sugary foods it requires from the atmosphere and the water. Surely none need cast contumely on such a plant as this!

Coastal Shrubberies.

The beautiful inlets of Stewart Island derive their charm in large measure from the assemblage of trees and shrubs along the water's edge, especially when the southern rata (*Metrosideros lucida*), its boughs almost dipping into the water, has burst into flaming crimson. In similar situations the inuka (*Dracophyllum longifolium*) and the smaller New Zealand flax (*Phormium Cookianum*) are common.

Where the coastal scrub of Stewart Island is densest, it has received the name of "mutton-bird scrub." This consists largely of the puheritaiko, a very fine shrubby groundsel (*Senecio rotundifolius*) (fig. 33), which makes an excellent garden plant even as far north as Auckland. The leaf is frequently 4 in. or more in diameter, and is covered so closely with a mat of buff-coloured hairs on the under-surface that it can be written upon. The leaf may thus be made to serve as a post-card, which can be posted at the most southerly office in Australasia—that on the Isle of Ulva, in Paterson Inlet.

In the West Coast Sounds this groundsel forms thickets, associated with some other shrubs, of which the principal are—the charming *Olearia operina*, *Veronica elliptica*, and *V. salicifolia*. A close relation of *O. operina*, the teteawaka (*O. angustifolia*) (figs. 34 and 35), which has flower-heads 2 in. or so in diameter, with violet centres, occurs in Stewart Island. There are also a few plants at the base of the Bluff Hill. These latter, unfortunately, are badly attacked by a

* The seed-leaves are green, and so they supply the growing plant with additional food-material of their own manufacture.

FIG. 34.—The Purple flowered Daisy-tree (*Olearia angustifolia*), growing at the Neck, Stewart Island. The tree on left is 10 ft. tall, its trunk 1 ft. 3 in. in diameter, and the rounded crown 21 ft. through.

Lands Department.] [Photo, L. Cockayne.

native parasitic fungus, one of the rusts, those protean plants which totally changing their form and habits, spend a part of their existence on one plant and another portion upon quite a different species.

Veronica elliptica, the coastal shrubby veronica, mentioned above, deserves a few words. In the first place, it is one of our South American connections. When fairly sheltered it is a fine upright-growing shrub, covered closely on its outer twigs with rather thick palish-green small leaves. Like all the other veronicas, its flowers have only two stamens. The corolla is at first bright purple, but soon fades to white. The scent of the flowers is delicious. It is abundant in the Auckland and Campbell Islands, the Snares, Stewart Island, the west coast of the South Island, and the east coast to about as far north as Dunedin. From the remainder of the South Island it is absent, but appears again on the shore of Cook Strait at Titahi Bay, near Wellington. Strange to say, it extends no farther to the north, though it grows freely from seeds, and may be cultivated at any point on the New Zealand coast.

FIG. 35.—Flower-heads of Purple-flowered Daisy-tree.
[Photo, J. Crosby Smith.

VEGETATION OF CLIFFS AND ROCKS.

Metrosideros tomentosa, the well-known pohutukawa, the Christmas-tree of which the Aucklanders are justly proud, was formerly much more abundant than at present. It grows frequently on the faces of cliffs, stretching outwards over the oyster-covered rocky shore. Some of its roots are fixed in the solid rock, and creep for long distances over the surface—a most remarkable sight—while others

are given off quite high up the trunk or from the branches; but these do not usually reach the ground. Not infrequently the pohutukawa is of a quite erect growth, as may be seen in many coastal forests (fig. 36). It occurs on the coast from the Three Kings Islands to Poverty Bay and Taranaki, and inland on the shores of Lake Taupo, Waikaremoana, Rotorua, Roto-iti, &c. Other common coastal trees in the north are the karo (*Pittosporum crassifolium*), *P. umbellatum*, and the whau (*Entelea arborescens*). On the trunks of the pohutukawa the perching-lily (*Astelia Banksii*) often forms enormous

Fig. 36.—Pohutukawa growing as erect many-stemmed Tree in School-grounds, Kawakawa, East Cape.

[Photo, L. Cockayne.

masses, and this also clothes the coastal cliffs. These, even when fully exposed to wind and sea, are abundantly beautified by the charming lily, *Arthropodium cirrhatum*.

The coastal cliffs of east Marlborough in due season become scenes of great floral beauty. Here the rather straggling shrub *Olearia insignis* has its home. Its large, thick, and very leathery leaves, buff on the under-surface, and its fine flower-heads, render it a conspicuous object. How a plant in such a position, growing as it does

on the driest rocks imaginable, can get sufficient food seems a mystery. It puts one in mind of William Watson's lines—

> Some adventurous flower
> On savage crag-side grown
> Seems nourished hour by hour
> From its wild self alone.

Growing in company with *O. insignis* is *Phormium Cookianum*, its leaves drooping from the cliff; the delightful *Veronica Hulkeana*, with varnished green leaves, whose masses of delicate lilac flowers have earned for it the name of New Zealand lilac; and the aniseed (*Angelica Gingidium*).

The only member of the gourd family in New Zealand is at the present time quite rare on the mainland, and it may be best seen on some of the outlying islands of the north. On the Little Barrier, at the foot of the cliffs, it is abundant, scrambling over the kawakawa (*Macropiper excelsum*), or ascending to the topmost branches of the pohutukawas.

Certain ferns are peculiar to the coast, and are frequent on the cliffs. The most widely spread is the sea-spleenwort (*Asplenium obtusatum*). The coastal hard-fern (*Blechnum durum*) occurs only in the southern part of the South Island and in Stewart Island, but it is abundant also in the New Zealand subantarctic islands and the Chathams. All the coastal ferns have very thick and stiff leaves.

The Salt Meadows and Salt Marshes.

Along the banks of tidal rivers and estuaries there is frequently low ground covered at flood tide with brackish water, or, where higher, subject merely to a periodical submerging. Of both such situations the covering is fairly uniform throughout New Zealand. Colonies of rush-like plants form the bulk of the vegetation. The most striking is the rush-like *Leptocarpus simplex*, whose stiff, reddish, jointed stems, a yard or more tall, render it very conspicuous. It belongs to a family (*Restionaceae*) confined almost entirely to South Africa and Australia. A true rush (*Juncus maritimus*, var. *australiensis*) is also very common, but it has not been found south of Timaru. Dotted over the salt meadow, or growing in close masses, is the shrubby ribbonwood (*Plagianthus divaricatus*), a shrub of a dense habit, and made up of slender, wiry, dark-coloured interlacing twigs covered

with narrow leaves, most of which it casts off in the autumn. Its relationship to the beautiful lacebarks and ribbonwoods is indeed concealed in its habit, but revealed in the structure of its minute flowers and fruit, as well as in its tough bark.

On the drier ground of the salt meadow are a number of creeping, turf-making plants, mostly with long roots and small thick leaves. The chief of these are *Samolus repens*, a white-flowered plant of the primrose family, but not a bit like a primrose; *Selliera radicans*, which has a curious corolla, looking as if a portion had been removed, also white; *Cotula dioica*, with aromatic leaves and yellowish button-like flower-heads; and *Atropis stricta*, a small grass. In some places, but by no means everywhere, growing in the pools or streams, is a beautiful musk (*Mimulus repens*). Its flowers are bright lilac in colour, with an orange throat. Extremely abundant also in some localities (*e.g.*, on the northern shores of Cook Strait), and dotting the ground everywhere, is the pretty relative of the last-mentioned, *Mazus pumilio*. The curious *Eryngium vesiculosum*, a plant of the carrot family, which can increase enormously by means of runners, and so become a weed, is an occasional salt-meadow plant.

Where the water cannot get away, and the ground is never dry, and uncovered only at low tide, will be found a salt marsh. In the wettest places colonies of the great bulrush (*Scirpus lacustris*) will be present, but only where the water is not too salt. More salt-enduring is the smaller *Scirpus maritimus*. *Leptocarpus simplex* will generally be the dominant plant, and will cover many acres to the exclusion of all else. A sedge, *Carex litorosa*, is peculiar to the salt marsh. Many of the plants mentioned above also occur, specially *Juncus maritimus*. These salt-marsh plants are of considerable economic importance, as they help to build up solid ground in estuaries, and also to maintain the banks of tidal rivers.

Botany of the Small Coastal Islands.

The small islands near the coast are of extreme botanical interest, and sometimes of great beauty. Some are quite in their virgin condition, while others have been changed by man, especially where the lighthouse-keepers lead their solitary lives.

On Stephen Island, in Cook Strait, famous as the home of the tuatara lizard, the last representative of a long-since-vanished race, can be seen every stage of human progress from the "forest primeval"

FIG. 37.—Interior of Forest of Stephen Island, showing spreading limbs of the Kohekohe (*Dysoxylum spectabile*). The slender upright stems are those of *Macropiper excelsum*.

[Lands Department.] [Photo, L. Cockayne.

to the cabbage-garden. This forest is quite a remarkable one, and such portion as still remains should be preserved from further destruction. It consists chiefly of the kohekohe (*Dysoxylum spectabile*), *Paratrophis opaca*, *Macropiper excelsum*, and *Rhapalostylis sapida* (the nikau palm). The trees are stunted, have many spreading branches, and are garlanded by the fern *Blechnum filiforme* (fig. 37).

Open Bay Island, off the coast of south Westland, is in its virgin state. It would be an unpleasant experience to pass a night there, since in its peaty soil, honeycombed by the holes of petrels, veritable leeches and wetas of huge size and formidable aspect abound. The vegetation consists of a most impenetrable scrub of kiekie (*Freycinetia Banksii*), almost the last survivor of a forest which must have clothed these islands long ago, when connected with the mainland of Westland. Very interesting, too, must be the Three Kings, where Mr. T. F. Cheeseman found abundance of that magnificent tree, supposed to be almost extinct, the puka (*Meryta Sinclairii*).

Only a brief reference can be made to the Poor Knights, recently visited for the first time by Captain Bollons and the author, where the big snail, *Placostylis Hongii*, is still abundant, and where the arborescent vegetation consists largely of *Suttonia divaricata*, an unexpected plant. Nor can the coastal meadows of Southland, white with gentian and eyebright, be described, nor the cliff vegetation of the Nuggets, where an alpine celmisia clothes the barren rock; nor many other charming spots, lapped by the many-voiced ocean. Sufficient, however, has been said to show that we need not climb into the clouds to find our wild flowers, and that those who are wont to take their pleasure sadly by the seashore may find there a field of new interest.

CHAPTER VI.

THE MEADOWS.

European contrasted with New Zealand meadows—The meadows of the Dominion—How meadows are formed by nature—Valuable indigenous grasses—Flowers of the lowland pastures—The mountain meadows—Colours of the alpine flowers—Buttercups, ourisias, yellow forget-me-nots—An alpine desert—Drought-resisting contrivances—Peat-forming plants.

Meadows in General.*

When the early settlers reached their antipodean home they must have been struck by the absence of green fields gay with buttercups, daisies, cuckoo-flowers, coltsfoot, and oxeyes, and would have laughed at the idea of New Zealand meadows. To many, even yet, it may seem absurd to compare the tussock slopes with the emerald hillsides of Britain. As for wild flowers, there are some who remember regretfully those of the Motherland, and lament that their adopted home has nothing to offer in exchange for the cowslips, primroses, anemones, bluebells, and heather of their youthful days.

Be all this as it may, New Zealand has plenty of natural meadows in a plant-geographical sense, if not in that of our boyhood. For those who will seek them, too, it has also wild flowers that can vie in beauty with those of any other region.

Natural meadows are a distinct expression of climate and soil, and, as stated in the first chapter, forest would cover the whole land were there no inhibitory circumstances. Such, however, exist, the most important being altitude, the nature of the soil, and climatic influences, especially constant wind. The tussock meadows of the Canterbury Plain, of the tableland near Mount Ruapehu, and of the slopes of so many of our mountains are expressions of the above fact. So, too, are the alpine meadows above the forest-line (fig. 38).

* Plant-geographically our "meadows" really belong to different biological categories, such as steppe, fell-field, &c.; but, as these terms are by no means clearly defined, I still use the term "meadow," as in my writings in general.

In the wet districts meadows are lacking, except on the high mountains. In the drier parts, such as eastern Hawke's Bay, eastern and central Otago, and the Canterbury Plain, they are much in evidence, and, where the soil is very stony, may even merge into deserts.

Besides the meadow lands just mentioned, there are in the Dominion many others where the fields are green enough, and where, at any rate, buttercups, daisies, and oxeyes are not absent, much to the regret of the farmer. But such fields are quite artificial, and afford

Fig. 38.—Forest (*Nothofagus cliffortioides*) giving place to Grass-land, the effect of wind. Near Source of River Poulter, Canterbury.

[Photo, L. Cockayne.

merely examples of the changes wrought by man—changes which he accomplished long ago in the British Isles, where the meadows, and forests too, for that matter, must be entirely different from those of primeval Britain, and where no natural combinations of plants now exist. And since the advent of the white man, New Zealand has year by year changed more and more, so that had not great national parks been wisely set aside, where it is to be hoped the vegetation will ever

remain undisturbed, the time would not have been far distant when the Dominion's beautiful vegetation—her most special characteristic —would be confined to a comparatively few spots of limited area.

Evolution of Meadows.

A very common feature of many parts of New Zealand, especially in the mountainous regions, is a broad shingly river-bed, bounded on either side by high terraces, or sometimes filling up a narrow valley. The water of these rivers is not usually confined to one channel, but meanders in several narrow streams over the wide stony bed, which in consequence is in places quite dry, and ready for plant-colonists. These are not slow to avail themselves of the chance to "take up land," and engage the wind or the birds to convey them to their new holdings, while some even travel by water.

Amongst the earliest settlers are the willow-herbs (*Epilobium*), thanks to their light seeds furnished each with a tuft of hairs. Various species of *Raoulia* come in a similar manner, and large, round, moss-like cushions or patches of silver and green result (*Raoulia australis*, *R. tenuicaulis*, *R. Haastii*). Lichens cover the stones with curious markings, and mosses spring up between them. As these earlier plants decay, humus is added to the silty, sandy soil, and various drought-resisting shrubs (*Discaria toumatou*, *Cassinia fulvida*, species of *Carmichaelia*) put in an appearance, together with grass-tussocks. Such shrubs may remain quite isolated, and the tussock become dominant, in which case the shelter will favour the settlement of many small herbaceous plants, including grasses, and a meadow will result. Or, on the other hand, some condition may favour arborescent growth — a natural shrubbery of veronicas, coprosmas, and other shrubs with wiry branches may appear, to be replaced finally by a beech forest. Meadows formed in this manner may be seen in process of evolution in many places, and it was in this way that the great river-made plains, equally with the "fans" of *débris* at the outlet of creeks, have been colonised by their plant inhabitants. When the forest on a hillside has been burnt, if there are frequent winds, trees cannot be reinstated, and meadow will result. Such fires have been frequent even in the pre-European days. Grasses, especially drought-resisting species, will have a much better chance of growth than trees after a fire, and a meadow will in an astonishingly short time replace the forest. This replacement is

quite assured when in the case of an upland beech forest (*Nothofagus cliffortioides*) the dry leafy floor has been burnt to the soil beneath and the tree-seeds destroyed. Bearing these facts in mind, and recognising the rain-forest climate of New Zealand, mentioned in Chapter III, it is not impossible that much of the Dominion now treeless, such as Central Otago, was long ago occupied by more or less extensive forests.*

Lowland and Montane Tussock Meadows.

The tussock meadows of the montane regions and the plains are of great commercial importance. They are, in fact, the home of those vast flocks and herds on which the prosperity of the Dominion so largely depends. The study of their plants is therefore of high economic interest.

Foremost come the grasses, replaced now in so many cases by those of Europe, and by the host of introduced weeds. Some of these indigenous grasses are most valuable for stock. The tussocks belong especially to two species—*Poa caespitosa* and *Festuca rubra*. As a food for stock the poa is not of much moment, but *Festuca rubra* is of considerable value. The blue-tussock (*Poa Colensoi*) forms much smaller tussocks than either of the above, and is a most valuable economic grass. Another grass of great importance is the blue-grass (*Agropyron scabrum*), still more or less abundant in some localities. The various forms of *Danthonia pilosa* and *D. semiannularis* are very important indeed, since they will tolerate burning and increase naturally upon the poorest ground, where they are probably of more value than any European grass that can be used. This must not lead the farmer to suppose that "danthonia," as all these different forms are called in the papers and by the seed-merchants, will ever replace rye-grass, cocksfoot, or red-clover in the better land. There, undoubtedly, the European grasses surpass any of the native ones; but these latter owe their importance to their suitability for poor ground and high country.

On the lower meadows certain plants with more or less conspicuous flowers are to be met with. Here are some of the buttercups (*Ranun-*

* This remark has no bearing on the question of very ancient totara forests, whose presence is suggested, as Mr. R. Speight has shown, by the abundance of totara logs in Central Otago and certain river-valleys of the Canterbury mountain-region.

culus hirtus, *R. multiscapus*), the slender bluebell (*Wahlenbergia gracilis*), the pretty *Convolvulus erubescens*, the creeping *Dichondra repens*, the yellow *Oxalis corniculata*, the small daisies (*Lagenophora petiolata*, *L. pumila*), and the little *Geranium microphyllum*.

The Meadows of the High Mountains.

To see the really fine displays of flowers which New Zealand can offer, one must seek the high mountains in the summer-time. Here the meadows are true natural gardens. But to view such in full perfection, those places must be visited to which no grazing animals have had access.

The real subalpine and alpine meadow flora begins on the mountains near the East Cape, and extends over the high summits of both Islands to the hills forming the southern part of Stewart Island. The South Island ranges are much richer in species than those of the North Island; but the closeness of growth in many places on the mountains of the latter, as on the Tararuas, Ruahines, and Kaimanawas, makes up for this difference. The mountains of Nelson, both east and west, are very rich in alpine plants. They contain some of the North Island species, together with others peculiar to themselves, and a large percentage of those found farther to the south. To the east the Kaikoura Mountains form a small but distinct district, having some special societies and a number of peculiar plants, of which the remarkable *Helichrysum coralloides* (the stout stems with closely pressed woolly white leaves looking not unlike coral, hence the name) and a veronica growing on the face of solid rocks (*V. rupicola*) may be mentioned. Proceeding southwards, we find that the Alps of Canterbury and Westland, crowned in many instances with perpetual ice and snow, form a barrier between the northern and southern alpine plants. These invade this mountain area on its borders, but it has plants peculiarly its own—*e.g.*, *Ranunculus Godleyanus*, *Helichrysum pauciflorum*, *Myosotis decora*.

The Otago alpine plants differ considerably as to species from those of Canterbury and Westland, and still more from those of Nelson and the North Island. Peculiar species are, *Veronica Hectori*, *Celmisia Petriei*, *Aciphylla simplex*, *Ranunculus Matthewsii*, &c. Finally, Stewart Island and the mountains of Southland have much in common.

These high mountain meadows are by no means closely growing associations of plants. On the contrary, these latter are generally in clumps, or dotted about, the ground between being quite bare, and the amount of bareness is governed by the rainfall. Thus, where the latter is great and the number of rainy days excessive, there is little bare ground except on the steepest slopes and near the mountain-tops, while on the mountains of Stewart Island the meadow is largely made up of bog-plants of the cushion form, through which grows a very strange grass (*Danthonia pungens*), with extremely rigid and sharp-pointed leaves (fig. 39).

If a foreign botanist, conversant with the alpine plants of other regions, were to visit a high mountain meadow in New Zealand, he would be amazed at the prevalence of white and yellow flowers, and the almost entire lack of reds and blues. His eye would encounter no blue gentians, no pink primulas. He would be much less surprised at seeing plant forms very similar to those of other alpine regions, yet bearing flowers quite different from his old acquaintances—*i.e.*, belonging to other families. This latter fact he would find an admirable illustration of the phenomenon that similar conditions evoke or preserve similar life-forms even in regions widely remote. As for the prevalence of white and yellow flowers, he would possibly have no suggestion of any moment to offer beyond that the white might be adapted for fertilisation at night-time by moths, and that yellow is a most frequent colour amongst flowers everywhere.

But if there is some monotony as far as the colour of our alpine flowers goes, there is none in regard to their form. The herbaceous plants of the European Alps in many instances die to the ground yearly, whereas those of New Zealand are mostly evergreen. The spear-grasses (*Aciphylla*) are of the Yucca form. Some are frequently cultivated in European gardens, but others still more handsome are unknown there. *Aciphylla Colensoi*, var. *conspicua*, derives its varietal name from the broad band of orange down the centre of each leaf-segment, which renders it an especially striking plant. *Aciphylla Monroi*, growing a few inches high out of a face of rock, looks not unlike a pigmy palm. *A. Dobsoni* has leaves of the most intense rigidity.

The eyebrights (*Euphrasia*) are real alpine gems. *Euphrasia Monroi* has rather big flowers, considering the size of the plant, white with a yellow eye (fig. 40); *E. Cockayniana* is yellow. The mountain

FIG. 39.—Typical piece of Boggy Subalpine Meadow, Stewart Island. The grass *Danthonia pungens* projecting semi-vertically.

[Photo, L. Cockayne.

[Lands Department.]

variety of *E. cuneata*, its large flower white with a yellow throat and marked with purple lines, is a most beautiful feature of Mount Egmont and other North Island mountains. Other pretty plants of this genus are *E. Cheesemanii* and *E. zealandica*. The eyebrights are in part parasites, living attached to the roots of grasses. This habit renders them exceedingly difficult to cultivate.

To *Ourisia*, a genus belonging exclusively to South America, New Zealand, and Tasmania, belong perhaps the most charming of our

FIG. 40.—*Euphrasia Monroi*, growing in bed of Punch-bowl Creek, near where the Arthur's Pass Tunnel is being constructed, surrounded by *Raoulia tenuicaulis*. [Photo, L. Cockayne.

plants. *Ourisia macrophylla* of the North Island, and *O. macrocarpa* of the South, are the tallest of the New Zealand species, and exceedingly handsome plants. *O. Cockayniana* looks rather like a stunted form of the latter, and forms large patches on the wetter mountains of Canterbury and Westland. *O. caespitosa*, creeping over stony ground, is in early summer a sheet of lovely blossoms. Also very beautiful are *O. sessiliflora*, *O. glandulosa*, and *O. prorepens*.

"Eyes blue as the blue forget-me-not," sings Tennyson, and the more prosaic modiste calls a certain silk "forget-me-not" blue. And yet New Zealand's forget-me-nots behave with antipodean topsy-turviness, and frequently produce not blue but yellow flowers!* Some of the yellow forget-me-nots that have their home in dim river-gorges or on wet shady rocks are of large size, and one (*Myosotis*

FIG. 41. — *Veronica linifolia* towards centre, *Raoulia tenuicaulis* on right, and one plant of *Angelica Gingidium* growing on the latter. Mountain above Arthur's Pass. [Photo, L. Cockayne.

macrantha) is bronze-coloured rather than yellow. In similar situations may grow the pretty little *Veronica linifolia* (fig. 41).

Of all the plants the buttercups most deserve mention. Of these there are quite a number, and they are far and away the finest butter-

* *Myosotis australis, M. Traversii, M. albo-sericea, M. Monroi.* Some have white flowers (*M. Cheesemanii, M. explanata*), or white with a yellow eye (*M. Goyeni, M. petiolata*).

cups on earth. The mountain-lily (*Ranunculus Lyallii*) is their queen. This world-famed plant raises great leaves from its very thick root-stock, each with a blade shaped like a saucer, sometimes more than 9 in. in diameter, and a stout stalk a foot or more in height, inserted in the middle of the blade, and lifting it high from the ground.

FIG. 42.—The Mountain-lily (*Ranunculus Lyallii*), growing on stony ground near source of River Rakaia.

[Photo, M. C. Gudex.

Excepting in the smaller *R. Baurii*, of South Africa, such leaf form is unknown in the buttercup family. In late November, December, and early January, *R. Lyallii* puts forth a very tall stem, bearing numbers of blossoms of snowy whiteness, there being frequently more than thirty on one stalk, each as big as a five shilling piece (fig. 12).

To behold this noble plant, an acre at a time in full bloom, is the sight of a lifetime to a lover of the beautiful. *Ranunculus Godleyanus*, a yellow buttercup found near the source of the Rakaia and its tributaries, is nearly as striking, and so also is the more northern *R. insignis*. The white *R. Buchanani* of the Otago mountains is splendid also; and mention must be made of the more recently named *R. Matthewsii*, which worthily bears the name of its energetic discoverer. The Mount Egmont buttercup (*R. nivicola*) is one of the features of that mountain, and is very plentiful also on the upper slopes of Tongariro.

FIG. 43.—*Celmisia spectabilis*.

[Photo, W. C. Davies.

R. lobulatus, a plant of easy culture and of large size, is confined to the Kaikoura Mountains.

Generic names are frequently hideous, but in *Celmisia* we have one dainty enough to take a foremost place among those feminine floral appellations now so popular. And well does a race of plants so beautiful deserve a fitting title. On every mountain-side at all seasons it is the celmisias (figs. 43 and 44) that give the characteristic stamp to the meadows, filling the air with aromatic fragrance, and delighting the eye with their beauty of form or abundance of flowers. With one

exception, all are true New-Zealanders, and are probably a remnant of the long-vanished meadow plants of sunken southern lands. Two special classes occur—those with fine upright rosettes, and those which trail over a considerable area, forming round mats. Some, again, have quite small rosettes, and form dense, silvery cushions, such as *Celmisia sessiliflora* and *C. argentea* (fig. 45). The most handsome of the celmisias is perhaps *C. coriacea*, a plant with large, stiff, silvery leaves, and flower-heads several inches in diameter.

Fig. 44.—Subalpine Meadow, Arthur's Pass, with colony of *Celmisia Armstrongii*. In background, tussocks of the grass *Danthonia Raoulii*. In centre, mat of *Celmisia discolor* var. *petiolata*.

[Photo, L. Cockayne.

Senecio scorzonerioides, notwithstanding its being burdened with its second name, is one of the most showy of New Zealand plants. The author will never forget the meadows near the source of the River Poulter, gleaming like snowfields with the multitudes of its pure blossoms.

Frequently the meadow is dotted with veronicas and other shrubs. Large breadths of an alpine *Astelia* are often present, also tall tussock-grasses such as *Danthonia Raoulii* and *D. flavescens*.

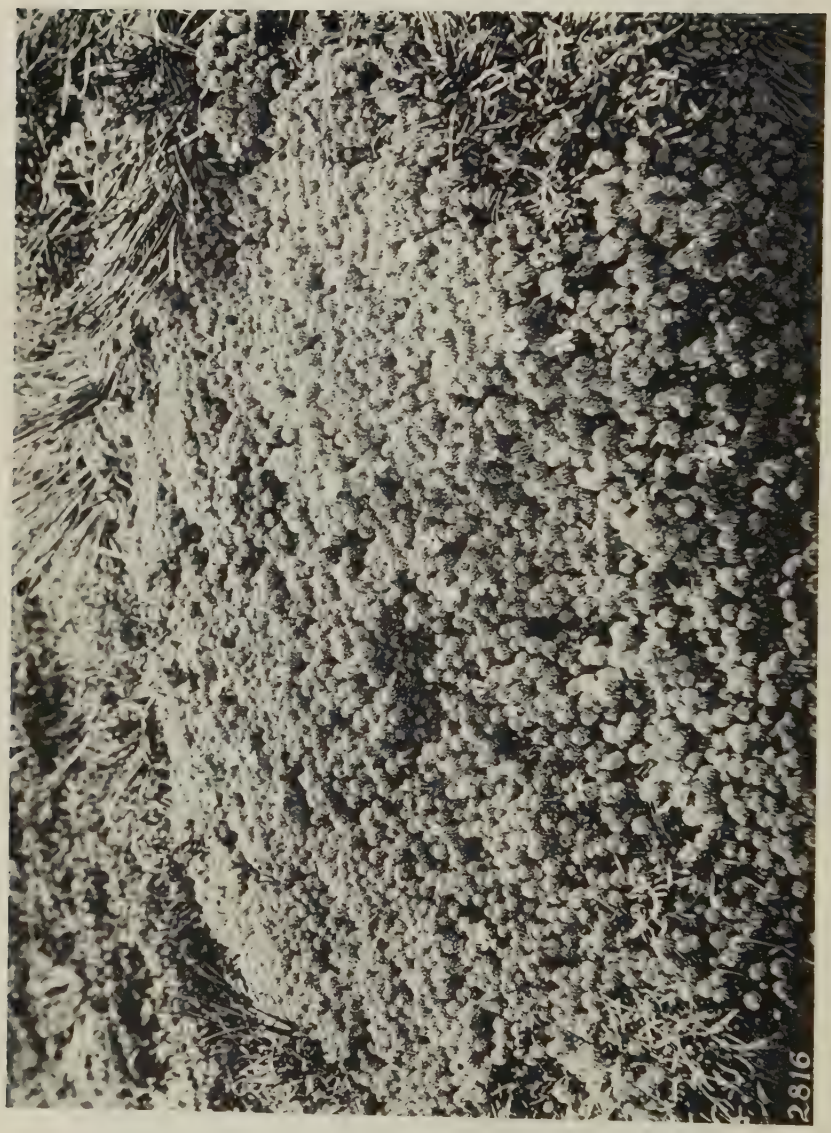

FIG. 45.—Cushion of *Celmisia argentea*, *Danthonia pungens* in right-hand top corner. Subalpine meadow of Table Hill Range, Stewart Island. [Photo, L. Cockayne, Lands Department.]

Shingle-slip Vegetation.

The rocks of the alpine summits weathering away, and the rain not being sufficient to bear all the *débris* into the valleys, an enormous quantity of angular stones collects on the mountain-sides in many places, which may form steep slopes for thousands of feet. As the traveller wearily ascends these "shingle-slips," as they are called, the stones constantly slip beneath his tread, and slide down the slope. Numerous large grasshoppers, grey as the shingle, leap from beneath his feet, an occasional black butterfly flits through the air or rests upon a rock, while overhead may fly screaming that famous bird the kea. All is a scene of utter desolation: it is, in truth, an alpine desert. Yet many of the meadows must have begun their career as shingle-slips, and all transitions may be noted from the one to the other.

To the shingle-slip proper belongs a most peculiar series of plants. They have several characteristics in common. All have long roots and are low-growing. Many are succulent. Most are of a colour similar to the shingle. Some have leaves of rather an indiarubber-like texture, and one, at any rate, is covered with an exceedingly woolly mass of hairs. These shingle-slips become burning hot in the sunshine, and yet in the evening of the same day may be icy cold. At some distance below the surface the stones are wet. Here are a few of the plants to be found in such situations: A stiff-leaved grass (*Poa sclerophylla*); a buttercup (*Ranunculus Haastii*); a plant of the carrot family (*Aciphylla carnosula*); a daisy, jet black, and with stamens like golden pin-heads (*Cotula atrata*); one of the pink family (*Stellaria Roughii*); the curious and sweet-scented penwiper plant (*Notothlaspi rosulatum*) (fig. 46); and a fleshy-leaved lobelia (*L. Roughii*). A piripiri, too (*Acaena glabra*), is almost confined to this peculiar station. These plants do not grow closely side by side. They are few and far between, and without close observation the slopes look quite bare. Occasionally a trailing-veronica (*V. epacridea*) sprawls over the stones, and is frequently accompanied by a smaller species of the whipcord form, *V. tetrasticha*.

On the shingle-slips the wonderful vegetable-sheep are encountered. These grow not on the shingle, but on the rocks which the stones have nearly buried. Large examples form great hummocks, 6 ft. long by 3 ft. across, or even more. Really they are shrubs of the daisy family, and are provided with a thick, stout, woody main stem and strong roots, which pass far into the rock-crevices.

Above, the stems branch again and again, and towards their extremities are covered with small woolly leaves, packed as tightly as possible. Finally, stems, leaves, and all are pressed into a dense, hard, convex mass, making an excellent and appropriate seat for a wearied botanist (figs. 47 and 48). Within the plant is a peat made of rotting leaves and branches, which holds water like a sponge, and into which the final branchlets send roots. Thus the plant lives

Fig. 46.—The Penwiper Plant (*Notothlaspi rosulatum*), growing on shingle-slip of a river-terrace. Castle Hill, Canterbury.

[Photo, L. Cockayne.

in great measure on its own decay, and the woody main root serves chiefly as an anchor. The vegetable-sheep are not inaptly named, for at a distance a shepherd might be misled. The two principal "sheep" are *Haastia pulvinaris* and *Raoulia eximia*; but there are other smaller ones—*e.g.*, *R. bryoides* and *R. Goyeni*, this latter of the Stewart Island mountain-summits.

Closely related to the shingle-slips, so far as the conditions for plant-life go, are the scoria-slopes of the volcanoes of the central plateau of the North Island. But on these the plant-life is still more scanty. Except *Claytonia australasica*, which, strange to say, is also a plant found in shallow running water, all the South Island shingle-slip plants are wanting. In their place is a true alpine gem, *Veronica spathulata*, which possesses a root of enormous length, small succulent leaves close to the cinders, and in summer is altogether covered with multitudes of snow-white flowers, which quite hide the foliage (fig. 49).

FIG. 47.—The Vegetable-sheep (*Raoulia eximia*), a rather small example, growing on rock rising from shingle-slip. Mount Torlesse, Canterbury.

[Photo, L. Cockayne.

Another veronica forms large mats, chiefly in the shelter of rocks (*V. Hookeriana*). It also is very pretty with its lilac flowers raised on moderate-sized stalks above the foliage. But the plant *par excellence* of the scoria deserts of the region in question—and they are deserts in all truth—is a species of *Dracophyllum* (*D. recurvum*), with stiff recurved leaves at the end of prostrate rigid naked branches. The shrub as a whole is of a reddish colour, and gives a characteristic stamp to the dreary landscape.

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Finally, the New Zealand edelweiss must be mentioned, of which there are two species, *Helichrysum grandiceps* and *H. Leontopodium*. Both are exquisite, and surpass their celebrated Swiss namesake, *Leontopodium alpinum*. Perhaps *H. Leontopodium* (fig. 50), when in full bloom, as it may be seen in late January on the Tararua and Ruahine Mountains, is the most beautiful plant in New Zealand. A near relation, but much more common, is *H. bellidioides* (fig. 51).

Fig. 48.—Bringing Vegetable-sheep from 5,000 ft. on Mount Torlesse for the Christchurch Exhibition of 1906–7.
[Photo, L. Cockayne.

Adaptations of the Alpine Plants.

High mountain plants live under conditions considerably different from those of the lower country. The climate is much colder, many are buried beneath a great depth of snow for several months, and all are subjected to frost at any period of the year. The atmosphere is more rarified than at lower levels, and this leads to stronger and more active sunlight, and to a more rapid loss of water from the leaves of the plants. Although the mountain climate is a wet one, yet when the sun is shining and the sky clear the plants are exposed to danger of damage from a too rapid loss of water. Nor are several

FIG. 49.—*Veronica spathulata*, growing on scoria desert, base of Ngauruhoe.

Lands Department.] [Photo, L. Cockayne.

FIG. 50.—The North Island Edelweiss (*Helichrysum Leontopodium*).
[Photo, W. C. Davies.

FIG. 51.—*Helichrysum bellidioides*, showing the white bracts of the flower-heads, which look like petals. Stony ground near Arthur's Pass.
[Photo, L. Cockayne.

days of sunshine in succession unknown even on the wet western mountains. In harmony with this danger of drought, with the cold of winter, with the heat of summer, and with the fierce wind-storms, the plants have developed, or preserved, special contrivances, or peculiar habits of growth, some serving frequently more than one purpose. Thus many plants are of most lowly growth. The genus *Dacrydium*, to which belong several lofty forest-trees, amongst others the rimu, is represented in the New Zealand mountains by a creeping-plant which grows at times so densely as to form an actual turf or a cushion (fig. 52). Many plants have the form of cushions, and very beautiful are the rounded green cushions of *Phyllachne Colensoi* and *Donatia novae-zelandiae*, especially when gemmed with multitudes of small white flowers.

Roots of an extraordinary length form an excellent provision for obtaining an abundant water-supply at all seasons, and these are very frequent amongst the alpine plants. But, above all things, the leaf, in structure and form, shows drought-resisting contrivances. The most common of all is a mat of hairs on the under-surface of the leaf, so characteristic of the celmisias (fig. 43). Some, again, such as the *Aciphyllas** (spear-grasses), have extremely rigid, vertical leaves, which both resist the wind and can never receive the direct rays of the sun.

Perhaps the most interesting feature of the New Zealand alpine plants, and one which is not so well marked in the alpine plants of Europe, but is seen in those of the Andes, is the capability of one portion of the living plant to turn into peat, while its remaining part grows vigorously, and even uses its own dead self as food material. This habit is not specially in harmony with an alpine climate, but rather with absence of sunlight and prevalence of rain and mist—just such a climate as exists in the subantarctic islands to-day. Most of the celmisias are surrounded at the bases of their leaves by quite a thickness of rotting leaves, and the same may be seen in a very large percentage of the New Zealand alpine plants. Such an adaptation perhaps indicates that our alpine flora originated not on the high mountains at all, but in the sunless and wet regions of the south.

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* In this book the plants generally referred to *Ligusticum* are included in *Aciphylla*. In this sentence only *Aciphylla* in the more restricted sense is intended.

FIG. 52. — The Dwarf-pine (*Dacrydium laxifolium*), which on the dry pumice soil has assumed the cushion-form. *Veronica tetragona*, a Whipcord-veronica, growing on it above, and small plants also of *Celmisia longifolia*. Volcanic plateau of North Island, at 3,700 ft. altitude.

CHAPTER VII.

PLANTS OF FRESH WATER, SWAMPS, AND BOGS.

Scarcity of aquatic plants in New Zealand—Water-ferns—The red *Azolla*—The pond-weeds — The water-milfoils — Fresh-water algae — Vegetation of hot springs—Effect of plants on changing the land-surface—Swamp vegetation —The niggerhead—Economic importance of swamps—New Zealand hemp —Bogs and bog-plants—Sphagnum and its peculiarities—Flesh-eating plants —A vegetable trap.

It has already been shown that in her forests, meadows, shores, and shrubberies New Zealand possesses plants which do not yield in beauty or interest to those of any other land. With her seaweeds, too, she is well able to hold her own. But when it comes to the fresh-water plants she must take a lower place. Rivers and lakes there are in plenty which offer first-class inducements for occupation by aquatic plants, but none of the more beautiful kinds have accepted the offer; in vain we look for water-lilies like those of the sister continent. Still, for all that, our waters are not without plant-life, some of which, from the biological standpoint, is interesting enough.

The Water-ferns.

Take the case of the floating water-fern, *Azolla rubra*. The red masses of this curious plant, covering still pools so thickly that one might think them dry land, must be known to all. The outer surface of the leaves is covered with minute excrescences, so that they cannot be wetted, and, in consequence, drops of water frequently begem them, glittering in the sunlight like diamonds. An individual plant is quite small, and consists of a thin, much-branched stem, putting down roots into the water from its under-surface, and bearing overlapping leaves. Each leaf consists of two lobes, which, except on close examination, look like separate leaves. Each lobe is adapted for a totally different condition of life, so there is a distinct division of labour in the one leaf. The upper lobes are comparatively thick, provided with leaf-green, and are therefore food-producers, and they are never submerged. Each contains a large cavity full of slime,

and inhabited by a fresh-water alga, which, however, does its host no damage, but, like a respectable lodger, probably pays for its accommodation. The lower lobe is partly submerged, and quite thin, so that it can absorb water. Moreover, the close arrangement of the leaves as a whole furnishes cavities where air can lodge, and so provides the necessary buoyancy for the floating plant.

To see other aquatic ferns the town-dweller must go much farther afield, visiting those solitary lakelets far in the mountainous region of the South Island that are traces of the ice-plough of ancient glaciers. On the gravelly beds of such cool waters lives the alpine quillwort (*Isoetes alpinus*), looking more like a tiny rush than a fern; and here, too, but in the deeper water and on a more muddy bottom, is the home of *Pillularia novae-zealandiae*, which also might easily be mistaken for a small rush. Some of the lakes in the Waikato and in the Taupo districts also contain another species of quillwort (*I. Kirkii*). Indeed, it is highly probable these plants are commoner than is generally supposed.

The Pond-weeds and Water-milfoils.

In most parts of New Zealand one may see, floating on the surface of slow-flowing rivers or calm sheets of water, the oval brown leaves of some species or other of pond-weed (*Potamogeton*), the commonest of which is *P. Cheesemannii*. Besides the above leaves there are others which live always submerged, and which differ considerably from the floating ones. These submerged leaves are very thin, erect, more or less ribbon-shaped, and are also extremely numerous. Since there can be no danger of want of water, such leaves are entirely without any protection on that score; on the contrary, they are so constructed as to be able to absorb water over their whole surface just like the filmy ferns of Chapter III, and thereby secure at the same time the oxygen which it contains. Their ribbon-like shape is well adapted to withstand damage from the currents of water, while sufficient extent of leaf-surface is provided by increase in number of leaves. It is also an interesting fact that these submerged leaves are similar to the early seedling ones of the pond-weed, and that this particular shape of leaf is common even amongst the land members of that great division of plants to which *Potamogeton* belongs. Some of the pond-weeds also never produce floating leaves—*e.g.*, *Potamogeton ochreatus* and *P. pectinatus*.*

* Found frequently in slightly brackish water.

The water-milfoils (*Myriophyllum*) differ from the pond-weeds in that they have no floating leaves, but boldly raise their upper portions above the water-surface. They agree, however, in the fact that the aerial leaves differ from the submerged ones. This is the more interesting because no line of demarcation on the erect stem separates the two except the water-surface—that is to say, the same tissue can change its leaf-form according to change of outer circumstances. The water-milfoils are graceful, feathery-looking plants, with the leaves frequently given off, four or more, from the same height round the stem. The submerged leaves are cut into fine segments, a very common occurrence in many water-plants, whereas the aerial leaves are broader and much less cut. Some of the water-milfoils are bog-plants rather than aquatics—*e.g.*, *M. Votschii.**

It is highly probable that all seed-bearing aquatic plants are descended from land plants, which took to the water through competition with rivals better suited than they to their original stations. This is no place to discuss this question, but it may be pointed out that some plants can live equally well on land and in water, and even do not mind being submerged. The water-starworts (*Callitriche*) are examples.

In many streams the native aquatic vegetation has been ousted by the introduced watercress or the American water-weed (*Elodea canadensis*). It is interesting to note how much the former varies in both leaf and flower when growing on dry ground by the sides of ditches. Both plants are noxious weeds, and it costs the country much money annually to keep open the watercourses where they flourish.

Fresh-water Algae.

Rivers, ponds, lakes, stagnant pools, moist soil, and many other stations are the homes of the fresh-water algae, or the pond-scums, as one section may be popularly called. They very frequently form green, slimy masses on the surface of the water. Common forms consist of what look like very fine, long, green hairs. Under a fairly strong power of the miscroscope these are seen to consist of long tubes, divided by thin walls into compartments, which contain plant-green, sometimes in the form of bands.

The fresh-water algae are a very large family, and, although

* *M. pedunculatum* (in part) of Cheeseman's Flora, p. 152.

occupying a low position in the plant-world, their structure is at times fairly complicated, and their methods of reproduction are quite elaborate. To this family belong the diatoms, the stoneworts (*Chara*, *Nitella*), and many others. In the hot springs of the North Island are some peculiar forms, belonging to the blue-green algae, which are able to exist in water of a very high temperature. These were recently studied by Professor Setchell, of the University of California, and in a letter to the author he states that none of the New Zealand forms can endure a temperature greater than 167° Fahr., which seems a bath quite hot enough in all truth!

These hot-water algae are sometimes cited to show how living organisms could exist in the early days of the earth when cold water would be unknown, and how such organisms may have persisted since those distant ages, and they or their congeners be the ancestors of our present plant-life.

Relationship between Lakes and Meadows.

Between lakes, swamps, bogs, and meadows there is a close connection. Sedges, raupo, rushes, and rush-like plants growing in the shallow water near the margin of a small lake may in time, through their decay, turn that part into dry ground, and advance farther and farther until a water-surface is no longer visible, the whole having become a raupo or phormium swamp. From this, the transition to meadow land is, in many cases, only a matter of time.

The blocking of watercourses with aquatic plants can soon convert a meadow into a swamp. Even on shingly river-beds, swamps at various stages of growth may be observed, and toetoe grass, palm-lilies, and phormium break the monotony of the scene.

Sinking of the land may bring about great changes in the plant societies, and remains of plant-life in bogs can teach much as to recent changes in the land-surface.

In the swamps in the neighbourhood of Christchurch large numbers of fallen trees are found, the remains evidently of a large coastal forest, which must have been replaced by swamp during a sinking of the land. So, too, on that narrow peninsula to the far north of Auckland is much kauri-gum to be met with in the bogs, a sure sign that the land stood considerably higher at the time it was occupied by the kauri forest, since that plant is most rare in swamps.

Swamp Vegetation.

A journey on any of the New Zealand main lines shows the traveller that swamps are a very common feature of the landscape, for they can be recognised at a glance by the dense growth of phormium or raupo (*Typha angustifolia*) and by those most curious plants, the niggerheads (*Carex secta*). Formerly, too, the scene was enlivened by that fine bird, the pukeko (*Porphyrio melanotus*), gay with red legs and bill and blue breast. Before the days of settlement these swamps were much more extensive, but some of those reported as being undrainable by the early surveyors now bear rich crops of grain or "roots."

Besides the New Zealand flax (*Phormium tenax*) and the raupo (*Typha angustifolia*) many other plants occur in swamps. The manuka has been mentioned in an earlier article. Other arborescent growths are the palm-lily (*Cordyline australis*) and *Coprosma propinqua*. Very characteristic is the niggerhead (*Carex secta*), a species of sedge which builds for itself tall and stout "trunks" out of its dead roots and root-stocks, from the summit of which, like shock-heads of hair, the long leaves droop. In such a position the plant is raised high above the water of the swamp, having thus made for itself a dry position very much better for its well-being. On the "trunk" of the sedge, the fern *Blechnum capense* finds a congenial home, as well as some small native plants—*e.g.*, the marsh-pennyworts, species of *Hydrocotyle*. Swamps are rich in several species of willow-herb, of which the beautiful *Epilobium pallidiflorum* and the very tall *E. erectum* need mention. Two buttercups, *Ranunculus macropus* and *R. rivularis*, are common, the latter being easily distinguished by its finely cut floating leaves. Here is also the home of the sedge family, to which the so-called "cutty-grasses" belong.

Swamps are of considerable economic importance in New Zealand. The manufacture of fibre from phormium—"New Zealand hemp," as it is now called—has become one of the staple industries of the Dominion. At present *P. tenax* is not cultivated, except for ornamental purposes, the wild supply being sufficient. But this will not last for ever. As the swamps are drained, the supply of flax diminishes. The old Maoris were experts in its manufacture, and recognised varieties much more suitable for their mats, &c., than the rank and file of the flax-plants. To such they gave special names. Now what the uninstructed Maori did could be performed much more thoroughly by

modern science. We live in the age of scientific plant-breeding. Day by day its importance is realised. Scientists are only now for the first time delving deeply into the mysteries of hybridisation. By scientific breeding, the sugar-beet has had its sugar-content increased more than 10 per cent.; and there seems no reason why the fibre-content of phormium, both as to quantity and especially as to quality, should not be augmented, and pedigree breeds of our "flax" come into cultivation.

Bogs and some of their Plants.

According as water varies in regard to the chemicals it holds in solution, so does it offer different stations for plant-life. Certain waters are rich in lime; in others this is wanting to a great extent, and acids are present instead. Therefore the presence of lime-rich or acid-rich water sharply separates water-soaked ground into the two classes, swamps and bogs. Of course, transitions exist between these. In addition, the water of a bog is coffee-coloured, and contains a large quantity of organic matter. Those small plants called bacteria, which play such an important *rôle* in adding the all-important nitrogen-compounds (nitrates) to the soil, are also scarce in bogs.

At a glance, bog-vegetation can be distinguished from that of swamps. The bog-moss (species of *Sphagnum*) is nearly always present in the former, and forms rounded cushions and hillocks of a whitish colour, on which many of the bog-plants make their home. For some unexplained reason bogs are physiologically dry, and consequently many of their plants must be protected against drought. It is with these unfortunates, indeed, a case of "water everywhere and not a drop to drink." Many bog-plants, owing to these adaptations, can exist excellently well in dry places. *Phyllachne Colensoi*, *e.g.*, a beautiful green cushion-plant of most dense habit of growth, thrives equally well in subalpine bogs and at the heads of alpine shingle-slips.

Bogs occur both in the lowlands and mountains. They are common on the narrow peninsula of the far North, and also occupy much ground in Stewart Island, the same brownish wiry-stemmed rush-like plant (*Hypolaena lateriflora*) being common in both localities. Many identical species occur in both lowland and alpine bogs, and those of Stewart Island at almost sea-level bear a close relationship to those of the Southern Alps.

Sphagnum possesses some characteristics which distinguish it from most other mosses. Its stems at their periphery are provided with thin-walled capillary cells, stiffened by fibrous thickenings, and communicating with one another and with the exterior by round openings. Thus water is rapidly sucked in by the plant and stored up, while by the capillaries formed by the cells it can be conducted downwards to all parts of the plant. Although the surface on which the sphagnum grows may be extremely wet, but little water comes from below, and then only for a very short distance. Thus a sphagnum bog is altogether dependent on the rainfall, and can only exist where this is abundant, an excessive precipitation allowing the plant to occupy even a rock-surface. As the upper portion of a sphagnum cushion grows, its lower part dies, and is converted into peat, great masses of which frequently accumulate. Such peat is used for fuel in many parts of the world, and at Waipahi, in Southland, is cut for that purpose to some extent, though such New Zealand peat is generally formed by many other plants in addition to sphagnum, or this latter may be altogether wanting. The upper surface of a sphagnum bog continues to rise in height, and any plants growing thereon must, like dune vegetation, be able to grow upwards faster than they are buried. The small pine, *Dacrydium Bidwillii*, common on subalpine bogs, is frequently buried by the too rapid growth of the moss, and may be observed in all stages of burial. On the sphagnum cushions themselves many plants will grow, owing to the absorption of pure water, which cannot live on sour peat itself.

Where a mountain-stream on flattish ground is unable to take away all the water, an excess accumulates, and a bog is formed. In such places shallow pools are frequent, between which are the sphagnum hummocks. Here is the home of another cushion-plant, much resembling *Phyllachne*, *Donatia novae-zealandiæ*, and a sedge of similar habit, with leaves arranged like a comb, *Oreobolus pectinatus*. Other plants occur in plenty—*e.g.*, a small celmisia (*C. longifolia* var. *alpina*), another with broader leaves (*C. glandulosa*), the slender grass *Deyeuxia setifolia*, certain plants belonging to the rather rare family *Restionaceae*, *Gaimardia ciliata* (fig. 53), *G. setacea*, and *G. pallida*, all cushion-plants, and looking like mosses. Here, too, will be a dense turf formed by a woody plant, *Dacrydium laxifolium*, that smallest species in the world of the pine-tree family.

Bogs occur even on the scoria of the central plateau of the North Island, if water oozes out of the ground in sufficient quantity. An interesting plant of these bogs is a member of the gentian family (*Liparophyllum Gunnii*), which has a very thick creeping stem and profusion of tiny white star-like blossoms. It may be pointed out that this plant is the sole species of the genus, which is found only in this country and Tasmania.

FIG. 53.—Cushion of *Gaimardia ciliata*, growing on a bog in Stewart Island.
Lands Department.] [Photo, L. Cockayne.

Very characteristic of bogs are the sundews (*Drosera*), and they deserve, at any rate, a passing word. As shown above, the bog-water lacks available nitrogen. The small, spoonlike leaves of the sundews are provided with glandular hairs, at the end of which a shining drop of fluid may usually be seen. This contains a substance which has the power of acting on animal matter in much the same manner as the gastric juice. Should a small insect alight on a drosera

leaf, it becomes entangled in the sticky fluid, and at the same time the hairs bend over and pin the victim fast. Thus does this tiny but bloodthirsty plant procure some of its nitrogenous food. All this family do not dwell in bogs ; *D. auriculata* is a plant of the heath, and climbs over grass-stems, &c. *D. pygmaea* has a remarkable distribution, having so far been found only at the two extremes of New Zealand—viz., on the Bluff Hill and in the far north of the North Island. It is a tiny plant, no bigger than one's little-finger nail, and so may be easily overlooked.

Species of the genus *Gunnera* are frequent in lowland bogs. Those near Invercargill contain abundance of *G. prorepens*. The New Zealand species are quite small—mere pygmies, indeed, in comparison with their huge-leaved Chilian relation (*G. chilensis*). But, notwithstanding this, both equally afford house-room to a species of *Nostoc*, a fresh-water alga, somewhat after the manner of *Azolla* before described. Perhaps the prettiest denizen of the bogs is the pale-blue liliaceous *Herpolirion novae-zealandiae*, which, when not in flower, may be mistaken for a grass. A companion plant is *Oreostylidium subulatum*.

The bog umbrella-fern (*Gleichenia dicarpa*) frequently occupies large areas of boggy ground, its pale-green leaves and brown stems rendering it very conspicuous. A creeping club-moss (*Lycopodium ramulosum*) is frequent in Stewart Island and on the west of the South Island, and farther north the somewhat similar *L. laterale* is encountered.

Before leaving the bogs, another flesh-eater must be mentioned, the bladderwort (*Utricularia monanthos*), a plant with small, showy, purple flowers. The bladderworts are quite without true roots, metamorphosed leaves functioning as such. In some instances the leaves develop in another abnormal way : they construct themselves into small bladders, which are furnished with a lid, which can open only from without inwards. This leads to an arrangement like that of certain mouse-traps, so that a minute aquatic animal may easily enter the bladder, whence it cannot escape, and so is digested in due course by the plant.

CHAPTER VIII.

THE PLANTS OF THE OUTLYING ISLANDS.

A goblin forest—The ancient forest of Antarctica—A seashore cushion-plant—Finest floral display outside the tropics—Giant tussocks—Young albatroses—Macquarie Island—The Snares—Disappointment Island—Beetles, spiders, and amphipods of the Bounties—Peculiar trees of the Chathams—A lovely shrub—The tree-groundsel—The great forget-me-not—The Kermadec Islands—Tropical plants on the Kermadecs.

The Subantarctic Vegetation.

Lands of mist and sleet and hail, of fierce squalls born in the icy south; cruel, rock-bound coasts, scenes of brave men's death, or of fierce struggles with the angry sea; lands of brown hills, enclosed by thick woods, weird and grotesque—in very truth goblin forests, patrolled and sentinelled by uncouth monsters of the deep: such impression may our far-off subantarctic islands give at first.

A closer view, and scenes more pleasing greet the traveller. Despite the ever-present gales, fields of magnificent flowers clothe the hills in summer-time. Within the forest, beneath the thick entanglement of gnarled and twisted branches of the trees, multitudes of ferns spread out their feathery fronds into the dim light. The knotted trunks, the fallen trees, the uneven ground, all are thickly covered with a mantle most delicate of translucent filmy ferns. Mounds of exquisite liverworts of many species adorn both forest-floor and boles of trees. Thickets of shrubs abound. All is one close mass of vegetation, save where long, bare paths of dark peat lead from the dim recesses of the forest, along which a startled sea-lion may glide, fearful of the intruder, or one at bay greet him with angry roar and open jaws.

It is in the Auckland Islands alone of these lonely lands that any true forests are to be found. In Campbell Island trees are altogether absent; densely growing shrubs clothe the lower slopes and fill the gullies. In Antipodes a few lines or patches of shrubs show as dark spots amongst the all-prevailing tussock, while on Macquarie Island woody plants are quite wanting.

Phil. Inst. of Canterbury.] FIG. 54.—Interior of Rata Forest of the Auckland Islands. [Photo, S. Page

The forest of the Auckland Islands consists for the most part of the southern rata (*Metrosideros lucida*). The other associated trees and shrubs are the haumakoroa (*Nothopanax simplex*), the evil-smelling karamu (*Coprosma foetidissima*), the inaka (*Dracophyllum longifolium*), *Coprosma ciliata*, *C. parviflora*, *Suttonia divaricata*, and, where the forest changes into scrub, *Cassinia Vauvilliersii*. The extraordinary manner of growth of this society; the close, even foliage of its roof; the twisted, far-reaching branches, semi-prostrate and arching trunks, and consequent lowness of the trees, are plainly the expressions of the tempestuous climate—rigorous enough in many ways, but never really cold (fig. 54). Within the shelter of the forest quite other conditions exist, so here flourish those plants that love an atmosphere saturated with moisture. As for the affinities of the forest, they are subtropical and not subantarctic. Here, of all places, where a beech (*Nothofagus*) forest might be expected, it is absent.

In some few parts of these subantarctic islands—namely, on Ewing Island of the Auckland Group, to a limited extent on the north of Auckland Island itself, and especially on the Snares—are small woods of another character. These are composed of the truly magnificent daisy-tree (*Olearia Lyallii*), found only in these islands, but closely related to *O. Colensoi* of Stewart Island, the New Zealand Alps, and the North Island mountains. *O. Lyallii* has great leathery leaves, which are green on the upper surface but pure white beneath, thus affording a delightful contrast when they are stirred by the wind. Probably this society is a modified remnant of the ancient forest of that latitude and farther south, which during the great expansion southwards of New Zealand in later Tertiary times was driven into its present narrow limits by the invading and more vigorous rata forest of the north. The meadows of herbaceous plants, too, are possibly to be similarly accounted for—that is to say, they are a remnant of the subantarctic meadows of long ago.

On the Snares, mixed with *O. Lyallii*, is the rare and beautiful small tree, one of the shrubby groundsels (*Senecio Stewartiae*). Strange to say, though this plant also occurs farther to the north, it has not been found on Stewart Island proper, but only on some of the small islands in its vicinity.

Some of the seashore plants are very wonderful. Here, almost to high-water mark, comes a splendid tussock-grass, *Poa foliosa*, with broad green leaves. On the rocks, almost where the sea washes,

are large green cushions of *Colobanthus muscoides*, hard as those of the vegetable-sheep; and near by will be frequently seen the shining green rosettes of a species of plantain (*Plantago carnosa ?*). Close by, where the kelp heaves on the restless waters, swims, quite fearless of man, as it has done for ages, the little flightless duck. From the cliffs droop green draperies of a most strange pale-green, soft-leaved grass (*Poa ramosissima*), while their summits are crowned with the sweet-scented *Veronica elliptica*. On the flat rocks beneath stands, sentinel-like, the Auckland Island shag, conspicuous with its glistening black back, spotless white breast, and flesh-coloured feet; and accompanying it is the pretty little mackerel-gull, with dove-coloured back, white head and breast, and brilliant red legs and beak.

The herbaceous plants are the special glory of the islands. Sir Joseph Hooker has declared that outside the tropics no such floral display is to be seen in any area of the same size. The monarch of all is a majestic plant of the daisy family (*Pleurophyllum speciosum*), the genus being purely subantarctic, though related to the asters of gardens. The leaves are of great size, and all are corrugated. In colour and general appearance they somewhat resemble pale-green velvet or plush, and they are so arranged at times as to look like shallow goblets. These are striking enough; but when the beautiful purple flower-heads are raised high above the leaves, dozens at a time, side by side, the spectacle is magnificent. There are perhaps three other species of the same family. One (*P. Hookeri*), with silvery leaves just tinged with green, dotting the upland meadows as far as the eye can reach, is a charming-enough sight. But how intensified is the beauty when there are present in large numbers, and also in full bloom, a fine yellow buttercup (*Ranunculus pinguis*); gentians pink, violet, and crimson (*Gentiana cerina*); the blue *Veronica Benthami;* the gorgeous orange-coloured liliaceous plant *Bulbinella Rossii;* the prince of forget-me-nots, its blossoms ultramarine (*Myosotis capitata*); and mats of the stiff rosettes of *Celmisia vernicosa*, the leaves like polished greenstone, and bearing many fine flower-heads with purple centres and white rays. Other magnificent plants are two of the carrot family, with great masses of close-growing purple blossom (*Aciphylla latifolia* and *A. antipoda*), the former with leaves reaching to the middle of one's thigh; and a close ally *Stilbocarpa polaris*, whose massive creeping stem afforded a valuable food for the unfortunate castaways of the "Dundonald."

The tussocks rank with the forest and the meadow as an astonishing feature of these islands. Their habit is that of the niggerhead described in Chapter VII. On Antipodes Island, and in some parts of the Auckland Group, they are in many places quite 4 ft. tall, and grow so closely that to make any progress at all one is compelled to walk upon their tops (see frontispiece). On Antipodes Island these tussocks take the place of arborescent growth, and it is curious to see the little parrakeet peculiar to the island perched and swaying on the drooping grass-leaves. Where the tussocks are lower, the albatros rears its young, bringing daily the supply of food. Here, too, the baby birds, clad in downy robes of snowy whiteness, each seated on its cheese-shaped nest, brave for months the piercing antarctic blasts, until their time shall come to seek the white-topped waves and follow in the wake of the great ships.

Although Macquarie Island belongs to Tasmania, biology derides the claims of nations, and emphatically declares it to be three-fourths New Zealand and the rest Fuegian. This latter claim is specially emphasized by the immense cushions of *Azorella Selago*, the Fuegian rival of our vegetable-sheep.

The Snares, the nearest to Stewart Island of the subantarctic group, do not contain nearly so many peculiar plants, though they have an *Aciphylla* and a species of *Stilbocarpa* not found elsewhere. They form, as might be expected, a connecting-link with Stewart Island.

Disappointment Island, in the Auckland Group, the scene of the terrible "Dundonald" wreck, is the home of countless mollymawks. Cast your eye over the dreary landscape, and you will see brown meadow dotted with white birds, and here and there patches of vivid green. This last arises from the presence of the antarctic burr (*Acaena Sanguisorbae*, var. *antarctica*). As the tussock, with its accompanying plants, is slowly but surely destroyed by the many generations of birds, this burr takes complete possession of the bare ground, thanks to its colonising-power, for the barbed fruits adhere to the feathers of the young birds, and so are spread broadcast. The burr is really quite a rare plant in the tussock meadow, and so we have a remarkable example of a plant originally of little importance becoming, in a virgin vegetation, virtually a weed. But tussock will again predominate, and gradual alternate destruction and rejuvenation of the vegetation will always be in progress—a natural rotation of crops indeed, thanks to the presence of mollymawks.

FIG. 55.—Penguins destroying Tussock Meadow. Low forest of *Olearia Lyallii* in the background, and tussocks, The Snares. [Photo, L. Cockayne.

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There yet remain for mention the Bounty Islands. So far as plant-life goes, their description is easy. A few seaweeds are on the rocks, while, where the sea cannot reach, the glitter of their monumental granite is dimmed only here and there by the green stain of an alga, their sole land plant. During part of the year these desolate rocks are a scene of busy life. Penguins in countless hosts stand in close array from base to summit of the islands (fig. 55).* Fur-seals bask on the warm rock, which everywhere by them and by the feet of former penguins is polished smooth as glass. Here, too, the mollymawk makes its curious nest of penguin-quills and guano, and beneath the stones in this latter is teeming life of beetles, amphipods, and spiders.

The Chatham Islands and their Plants.

At a distance of about five hundred miles from the coast of New Zealand, and almost due east from Lyttelton, lie the Chathams. This group has a flora quite as interesting as its subantarctic sisters, but, owing in part perhaps to the milder climate and more northerly situation, of a different character. Subalpine meadows, fields of herbaceous plants, rata forests—all these are absent. A forest of another character flourishes, distinct, too, from any other of New Zealand. The trees have a very familiar appearance ; they look old friends, but are somewhat different. Surely this is the well-known koromiko ; but never did one see that as a tree 50 ft. in height. Here is the lancewood, but where is the well-known juvenile form ? Here, too, is the korokia of the north, yet its leaves seem larger and its yellow fruits bigger. The truth is that long isolation from the mainland has, in some way or another, led to slight differences between many Chatham Island and New Zealand plants. They have certainly come from a parent stock—perhaps one or the other is the actual parent; but now, although closely related, they are for the most part distinct species. The lancewood is neither *Pseudopanax crassifolium* nor *P. ferox*—it is *P. chathamica ;* the koromiko is not *Veronica salicifolia*—it is *V. gigantea ;* while the korokia is named *Corokia macrocarpa*, and in its larger fruit and broader leaves is distinct from *C. buddleoides* of the North Island.

* The photo. represents a penguin colony on the Snares, not on the Bounties ; but the general effect is similar.

The commonest of the forest-trees is the karaka, here called kopi (*Corynocarpus laevigata*), whose smooth bark was frequently adorned with a figure of a three-fingered man by the Moriori artists (fig. 56). Then come the matipo (*Suttonia chathamica*), the mahoe (*Hymenanthera chathamica*), an indigenous daisy-tree (*Olearia Traversii*, akeake), the tree-karamu (*Coprosma chathamica*), the lancewood (*Pseudopanax chathamica*), the ribbonwood (*Plagianthus chathamicus*), the nikau (*Rhopalostylis sapida*). There are two distinct classes of forests on the island, that on the higher ground containing fewer species, and having the large heath, *Dracophyllum arboreum*, as its dominant tree.

Fig. 56.—Moriori Figure cut in Bark of Kopi-tree (*Corynocarpus laevigata*). Forest of Chatham Island.

[Photo, L. Cockayne.

The forest on the limestone formation near the great lagoon, the Whanga, is also somewhat different, since there alone is the kowhai to be found.

There is no shrubby undergrowth in the forest, but tree-ferns and ferns of all kinds are very abundant. The only lianes are the supple-jack, the climbing-convolvulus (*Calystegia tuguriorum*), and *Muehlenbeckia australis*. Many most characteristic New Zealand forest-trees

are quite absent—*e.g.*, all the taxads, the beeches, the palm-lilies, and the pittosporums.

The despair of the settler and the delight of the flower-lover are the very numerous bogs of the Chatham Islands. These are frequently occupied by a close growth of the Chatham Island aster (*Olearia semidentata*), a truly lovely shrub in every respect (fig. 57). Covered in the summer-time with flower-heads of the most intense purple, these olearia shrubberies are an entrancing spectacle. *Olearia*

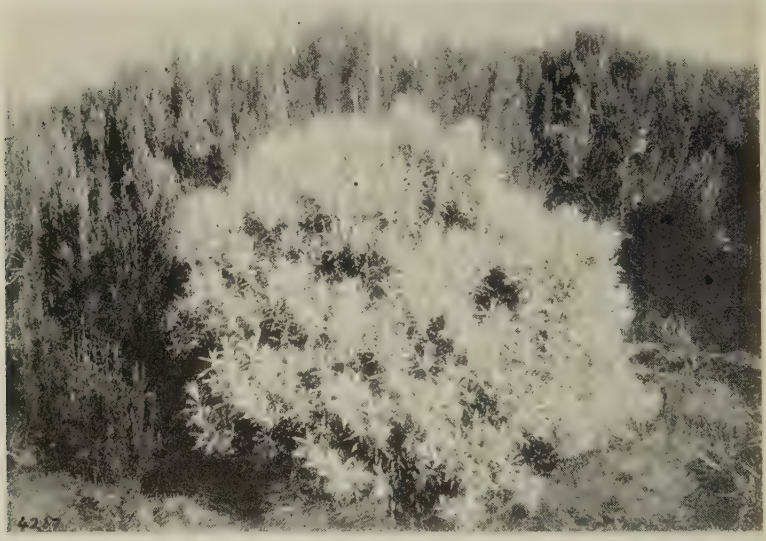

Fig. 57.—*Olearia semidentata* in foreground; *Dracophyllum paludosum* in background. Bog, Chatham Island.

[Photo. L. Cockayne.

chathamica is not so common, but occurs in quantity on the summits of those precipitous cliffs forming the south coast of Chatham Island: its flowers are white. Growing in company with *O. semidentata* is *Dracophyllum paludosum*, a needle-leaved shrub 3 ft. or 4 ft. tall, but which, when growing on sphagnum, sometimes blooms when only an inch or two high.

In the neighbourhood of these olearia bogs the margin of the forest often consists entirely of the rautini (*Senecio Huntii*), a mag-

nificent tree-groundsel, which produces immense bunches of yellow flower-heads, and has aromatic pale-green leaves in semi-rosettes at the ends of its stiff, bare, brittle twigs. For many hundreds of yards at a time this belt extends, forming, when covered with its golden blossoms, a gorgeous mass of colour.

On the dry open ground a heath society occurs, in which the rounded bushes of *Styphelia robusta* (fig. 58), covered in the autumn with white or red "berries," are conspicuous. Here, too, is the Aus-

FIG. 58.—*Styphelia robusta.*
[Photo, J. Crosby Smith.

tralian *Styphelia Richei*, which has recently been discovered also in New Zealand proper.

The most famous of all the Chatham Island plants is the giant forget-me-not (*Myosotidium nobile*) (fig. 1), frequently called by the absurd name of Chatham Island lily, or, what is worse, Macquarie cabbage! This wonderful plant, found nowhere else in the world, is now almost extinct. Formerly it extended almost round the main island, forming a broad belt on the sea-shore, just above where the dry

seaweed marks the high-tide limit. The massive, shining, broad, green leaf-blades, a foot or more in length, raised high from the ground on stout leaf-stalks, and the numerous blue flowers, each half an inch or so in diameter, render this plant a most conspicuous object. The seeds germinate rapidly if fresh, and seedlings are raised with the greatest ease. The writer has long thought this noble plant might easily be naturalised on our northern sea-shores—for instance, on the Little Barrier and on Kapiti. Surely some effort could be made to fence a piece of the Chatham Island shore from sheep and pigs, so that this rare and interesting plant could once more reassert itself in its natural station.

Other interesting Chatham Island plants are the mutton-bird plant (*Cotula Featherstonii*), which grows only near the holes of the petrels; the shrubby speedwells, *Veronica Dieffenbachii*, *V. Barkeri*, and *V. chathamica*, this latter a charming little plant, of which there are many distinct forms, which creeps over rocks close to the sea; the great sowthistle (*Sonchus grandifolius*), which grows on sand-covered ledges of rock near the sea, or at times on the dunes; the bog-grass, *Poa chathamica*, an important fodder plant; the Chatham Island cranesbill (*Geranium Traversii*), of which there are white and pink varieties; the swamp-matipo, *Suttonia Coxii*, with its pretty mauve fruits; the gentian, *Gentiana chathamica;* and two spear-grasses, *Aciphylla Dieffenbachii* and *A. Traversii*.

Settlement has in many places quite changed the face of the country. In some places are fine grass paddocks, in others the bracken-fern and the piripiri (*Acaena novae-zealandiae*) have become weeds. *Phormium tenax* was originally very common, but is now a thing of the past in most cases. The Chatham Island variety differs from any in New Zealand proper in its broad and rather drooping leaves and their weak fibre.

The Kermadecs.

Science is especially indebted to Mr. T. F. Cheeseman, F.L.S.,* for a knowledge of the most northern members of the New Zealand biological region, the Kermadec Islands. As the writer has not had

* Recently, Mr. W. R. B. Oliver, of Christchurch, spent, with some companions, nearly a year on the island, and has in Trans. N.Z. Inst., Vol. xlii, a full account of the plant-covering.

the pleasure of visiting this group, the following account is based on Mr. Cheeseman's admirable paper on the subject published in 1888.

From the subantarctic islands to the subtropical Kermadecs is a long step, and yet the dominant tree in the latter is also a *Metrosideros* (*M. villosa*), a relation, however, of the pohutukawa and not of the southern rata. But with this the similarity between the two regions ends, except that both are of volcanic origin; and there is no more outward resemblance between the plant-forms than there is between the climates.

As seen from the sea, there is nothing in the appearance of the plant-covering of the Kermadecs to recall the tropics. No feathery cocoanut-palms fringe the shore. On the contrary, the rather dull hue of the New Zealand foliage, as seen from a distance, is everywhere manifest.

Sunday Island, the largest of the group, is forest-clad, while Macauley Island is almost entirely without arborescent growth. The whole group is of volcanic origin, as stated above, and the small Curtis Island is still in the solfatara state.

A certain number of tropical plants have reached the Kermadecs, but nothing like what might be expected. Amongst these are—*Ipomaea pes-caprae* (which forms the well-known plant society on so many tropical shores), *Canavalia obtusifolia* (a climbing leguminous plant), *Ageratum conyxioides* (which bears the name of cherry-pie, or wild heliotrope), *Aleurites moluccana** (the candlenut of the Polynesian Islands), and also some grasses and one or two ferns.

Certain plants are peculiar to the group. Amongst these are two coprosmas, *C. petiolata* and *C. acutifolia*, the former closely related to *C. chathamica*, of Chatham Island; *Suttonia kermadecensis*, related to a Norfolk Island plant; *Homalanthus polyandrus*, a tree of the spurge family; and two fine tree-ferns, *Cyathea Milnei* and one discovered by Oliver and named by him *C. kermadecensis*.

But the rank and file of the plants are such as would be met with in the North Island—for example, the karaka, ngaio, wharangi (*Melicope ternata*), mahoe, tutu, ivy-tree (*Nothopanax arboreum*), &c. In fact, about four-fifths of the flora† consists of ordinary New Zealand plants.

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* According to Oliver this is not indigenous.

† According to Oliver there are 114 species, which belong to 88 genera and 42 families.

CHAPTER IX.

THE NATURALISED PLANTS.

Plant colonists—Origin of the naturalised plants—Method of arrival—Statistics—Distribution—Definition of term "weed"—Origin of weeds—Bracken, manuka, and piripiri as weeds—Weeds and human beings—The horned poppy and marram-grass—History of a pasture—Microscopic weeds—A Chatham Island orchard—The struggle between native and introduced plants—Equipment of aggressive species—Origin of a gum forest—Plant-sanctuaries—Esthetic value of acclimatised plants—Hedgerow plants—Likelihood of new weeds—Eradication of native species.

In the preceding chapters only the native plants, the true New Zealand aborigines, have been considered. But, besides these, a host of foreigners—of colonists, if you will—have overrun the land. These have not merely settled down side by side with their antipodean relatives, but in not a few instances have driven them from the soil. That characteristic stamp which the native vegetation gives to the New Zealand landscape has frequently disappeared, and another—almost English in appearance—has come in its stead. Newcomers from the Motherland look in vain near most of the cities for any sign of a foreign land, and, judging from the plant-covering alone, might well believe themselves back in Britain. A full account of this plant colonisation and of the bitter struggle between the invaders and indigenous species would be an important contribution to science; but it can never be written, since records as to the arrival of most of the plants or their wanderings in their new home are wanting. Here only certain general principles can be touched upon and a few illustrative details cited.

Already so widely spread and so abundant are many of the species that a beginner in the study of the New Zealand flora could not possibly tell amongst the specimens he might collect which were indigenous and which introduced. Even experts cannot agree as to the nativity of certain species, and discussions have taken place, as in the case of the wireweed (*Polygonum aviculare*).

The naturalised plants have come from many lands, but by far the greater part are, as in the analogous case of the human colonists,

natives of Great Britain and Ireland.* There are also Australians, North and South Americans, Africans, and Asiatics. Unlike the ancestors of the indigenous species, the aliens were not borne hither by winds or birds, or over ancient land-extensions now submerged; but the ships that conveyed the human immigrants or their goods brought the plants also. Some were purposely introduced for their economic (grasses, leguminous plants, vegetables, trees, &c.) or ornamental value; others came unbidden as impurities in agricultural or garden seeds, in ballast of ships,† in the hay or straw packing of goods, and in other ways. So thoroughly has the acclimatisation of these plants succeeded that there are now more or less firmly established about 530 species, some being abundant from the North Cape to Stewart Island, and quite at home even on the highest mountains.

Moreover, the species here under discussion, leaving out of consideration for the present the non-flowering plants, are a most varied assemblage, since they belong to no fewer than sixty-six families and 287 genera. Certain of these families are not represented in the indigenous flora —*e.g.*, the poppy family (*Papaveraceae*), the mignonette family (*Resedaceae*), the valerian family (*Valerianaceae*), the teasel family (*Dipsaceae*), and some others. Most numerous of all, as might perhaps be expected, are the grasses (eighty-one species), which surpass in number even the great composite family (seventy species). Then come the pea family (*Leguminosae*, forty-nine species) and the cress family (*Cruciferae*, thirty-six species). Other fairly large families are those of the pink (*Caryophyllaceae*, twenty-six species), sage (*Labiatae*, twenty species), dock (*Polygonaceae*, fourteen species), buttercup (*Ranunculaceae*, thirteen species), rose (*Rosaceae*, fifteen species), potato (*Solanaceae*, thirteen species), carrot (*Umbelliferae*, twelve species), figwort (*Scrophularinaceae*, eighteen species), poppy (*Papaveraceae*, ten species), and borage (*Boraginaceae*, ten species). On the other hand, some families are represented by only one species—*e.g.*, the gentian (*Gentianaceae*), primrose (*Primulaceae*), and periwinkle (*Apocynaceae*).

Proceeding through New Zealand from north to south, we find that the acclimatised plants slowly decrease in numbers. Some

* Such species are not confined to the British Isles, but are natives of northern and central Europe as well, many being also found in Europe generally, and extending into Asia.

† Mr. T. Kirk gives a list of 104 plants introduced in this manner, of which 20 per cent. were new to New Zealand, some being South American.

which are conspicuous in the Auckland Province—the pokeweed (*Phytolacca octandra*), for instance—are absent farther south. Altitude also thins the ranks, and at 3,000 ft. elevation, or less, indigenous and foreign species meet on equal terms. On the sheep pastures of the Southern Alps the beautiful alpine plants are still in abundance. A condition of fair stability has come about, and new plant societies have been formed in which the foreign invaders just hold their own. But change the condition of affairs by fencing a portion of land from the sheep, and the indigenous plants will at once increase. At 2,500 ft. on the mountains of southern Nelson, Canterbury, and Otago the gorse (*Ulex europaeus*) does not spread far and wide, as in the lowlands, nor does it assume any remarkable dimensions.

Amongst the introduced plants the most notorious are those known by the opprobious term of "weed." We all must know, though at the present time it is difficult to conceive such a state of affairs, that before the advent of the white man, and even for some considerable time afterwards, there were no weeds in New Zealand. Mr. T. W. Adams tells me how his land on the Canterbury Plain was at first weedless.* A little further thought, and it is plain that in any virgin vegetation weeds must be unknown, for what is a weed but merely some plant growing where it is not wanted? The mere presence of man in a new land, then, creates weeds. There is no occasion for a plant to be in itself useless to man to constitute it a weed. The best of plants, such as potatoes, if growing unbidden in a flower-garden may become weeds for the time being. Even in a New Zealand taxad forest all the trees not required for milling purposes are weeds, or a forest occupying ground intended for grazing is a distinct weed association.

Such well-known weeds as the sorrels, docks, fat-hens, and thistles would in the original primeval world each have its proper place in the primitive plant association to which it might belong, and would be present in no abnormal numbers. It was the changes brought about by cultivation, fires, and the close grazing of domestic animals which upset the balance of nature. Then those plants whose structure and habits were most in harmony with the changed conditions would become more numerous at the expense of the less well-equipped, and as the conditions antagonistic to the plant association as a whole

* Of course, there would be plenty of introduced plants, but he meant those kinds which overrun the land, and so become a nuisance.

increased, so would the best-suited species increase. All this is to say that many plants are potential weeds, ready to become active ones as soon as suitable conditions arise. Thus, through the long centuries of cultivation in Europe, aided by the ever-expanding intercourse with other lands, the great army of now almost cosmopolitan weeds has been gathered together—the very pick of the vegetable world for thriving under the artificial conditions imposed by man in temperate regions. It is the old story that when one interferes with nature she exacts remorselessly her tribute.

It is only in a virgin vegetation that we can actually witness the evolution of a weed. Our own flora has furnished some rather striking examples. The common bracken-fern (*Pteridium esculentum*) is a case in point. This plant can be transported over great distances by means of its tiny spores, which, light as the finest dust, are carried for many miles by the wind. It has a stout far-creeping underground stem full of nutritious starch. Consequently, when the farmer burns its leaves and the grasses and other plants in its neighbourhood, the stem remains unhurt beneath the ground, and from its store of food can soon construct fresh leaves. Owing to their form and internal structure, these are capable of enduring considerable drought, so that the plant need not be at all concerned about its water-supply; consequently, all things considered, the bracken is a fair example of a potential weed. Nor does it belie this expectation, for at the present time this fern, worthless from the farmers' point of view, is far more abundant than in primeval New Zealand.

So, too, with the manuka (*Leptospermum scoparium*), thanks to its abundant and quickly germinating seeds, its hard seed-capsules that are not easily destroyed by fire, the early blooming of the seedlings, its leaf-form and structure, its toleration of most varieties of soil, and its extreme plasticity with regard to changes of environment. Miles of manuka now exist where originally forest or a mixed shrubbery flourished.

Several species of piripiri (*Acaena Sanguisorbae* various varieties, *A. novae-zealandiae*) have become troublesome weeds. In their case the barbed "seeds"* are easily carried by domestic animals, especially sheep and dogs. On bare ground they readily germinate,

* Really a dry fruit which contains one seed, and does not split open at maturity. The calyx, which is furnished with several barbed bristles, remains attached to and encloses the fruit proper.

the plant growing rapidly, and extending its prostrate stems over a considerable area. Even on parts of the subantarctic islands the piripiri of that New Zealand plant province (*Acaena Sanguisorbae* var. *antarctica*), as was shown in Chapter VIII, becomes abnormally abundant on ground trodden bare by the multitudes of albatroses, the young of which on their way to the sea assist in spreading the "seeds" which have become attached to their feathers.

Other native plants, though not actually aggressive, hold their own on grazed land owing to certain qualities they possess—*e.g.*, species of *Geranium* (low growth, long roots); *Oxalis corniculata* (low growth, spreading habit, quick germination); species of *Cotula* (low, turf-forming habit and far creeping and rooting stems); *Senecio bellidioides* (rosettes close to ground, wind-borne "seed," deep roots); *Coriaria ruscifolia** (poisonous, much-spreading underground stem which puts forth shoots when the plant above ground is destroyed by fire).

The term "weed" is evidently merely relative, and depends upon the plant in its relation to man. If we leave the human element out of the question, a weed is simply a living organism, like any other plant or animal, and its habits and structure are entirely for its own benefit, just as are the organs of all animate beings. In itself there is nothing noxious at all, nor in an undisturbed plant society would it react upon its neighbours more than any other plant.

The flourishing "weed" of civilisation, so far as the plants with which it comes into contact are concerned, is much the same as is civilised man in relation to the savage. In an environment of wild nature, as a hunter with rude weapons of stone, bone, or wood, and inured to cold and hunger, the latter is in a far better position than the European under like circumstances. But should the civilised man, armed with the arts and under the surroundings of civilisation, come in contact with the savage, the latter is rapidly displaced.

Nor is the colonisation by introduced plants very different from human colonisation. Some plants, through their special favourable qualities and adaptability—in other words, through their power to make the best possible use of their circumstances—outdistance their fellows, and establish themselves far and wide, living in great security, and growing with a luxuriance not attainable in their mother-land.

* This becomes aggressive in certain localities.

Others flourish, it is true, but, lacking adaptability, are narrowly restricted to a definite and well-defined station out of which they cannot go. On the shores of Cook Strait the horned poppy (*Glaucium flavum*) is confined to gravelly and stony beaches. On the clayey hillside near Lyall Bay is a fine colony of this striking plant, with its silvery foliage and delicate yellow flowers; but it is strictly limited to a spot where a quantity of gravel and coarse sand has collected. The well-known marram-grass (*Ammophila arenaria*) can grow only where there is drifting sand. Cut off the supply, and the green leaves quickly assume a sickly yellow hue, and, if no more sand comes, the plant will eventually die. Certain species may become established in a few places, but can spread no farther. Especially is this the case with the plants of old gardens, which may linger for years, but, failing to reproduce their kind, finally die out. Lastly, many species thrive well for a time, but are eventually eradicated by more vigorous competitors.

Nowhere can this last example be better seen than in pasture land. At first the newly laid-down grass may consist of valuable rye-grasses (*Lolium perenne, L. italicum*) and clovers. In time, owing to its perennial habit, the first-named will overcome the annual species, which is unable to reproduce itself freely from seed on the closely occupied ground. The adult plant, too, dies at the end of the year. Next, through the action of cattle, sheep, and horses, the perennial rye-grass is eaten to the ground, while those grasses worthless for feed which have crept in, such as the soft brome-grass (*Bromus hordeaceus*) and Yorkshire fog (*Holcus lanatus*), increase at a great rate, their flowers being untouched and their reproduction not hindered. Finally, the pasture deteriorates so much that it must be broken up and laid down afresh.

Before leaving the question of weeds, those minute organisms must be mentioned which, settling down upon other plants and living as parasites, damage and not infrequently kill the host. To this category belongs that vast assortment of non-flowering plants commonly termed "blights." Many of these are members of the great family of fungi. For the most part they are more or less invisible without the aid of the microscope, but their presence is often writ large on the unfortunate host-plant. The rusts and smuts, the so-called Irish potato-disease, the organism causing "damping off" in seedlings, and many and diverse causers of plant-diseases belong to the "blights."

Right at the north-east corner of Chatham Island is an old orchard planted before the middle of the last century. At the time of my visit, some years ago, I was astonished to learn that blights of all kinds were quite unknown there, the extreme isolation of the orchard having proved its salvation. And so, too, it was with New Zealand orchards in the early days, before the coming of the microscopic weeds. Many of the ills which afflict humanity are due to the presence of extremely minute introduced plants known as bacteria, the "microbes" of the journalist, and so various diseases now common in New Zealand were absolutely unknown to the Maori.

From the plant-geographical standpoint, of particular interest are any facts bearing on the struggle between the introduced and indigenous species. The primary point to insist on is that so long as the surface of the soil is left intact—that is, if the primitive plant-covering be quite undisturbed—it is very hard indeed for the world's selected weeds—even those best equipped for aggression—to gain a foothold, and it is almost impossible for them to spread. On the Snowcup Range, in Canterbury, there is a clear line of demarcation between the meadows which are virgin and those where sheep are pastured and burning is periodical. On the latter are introduced plants in abundance, side by side with tussock-grasses, gentians, and spaniards; but on the former there are merely the celmisias, buttercups, groundsels, and other mountain plants, the foreign invaders being altogether absent. And yet the native dandelion, which is closely related to the introduced species, is in abundance in many places, and the violent westerly winds must be charged at times with the seeds of certain weeds.

Ruapehu, the upper portions of Egmont, and the mountains of Stewart Island and elsewhere, especially on the west of the South Island, are weedless. So, too, are the virgin forests. Disturb the ground, however, and at once a seed-bed is ready, and the foreigners pour in. Burning makes more space, and they spread and increase, the native plants decreasing in proportion, and going to the wall. Grazing animals assist in the destruction. The native plants having come into being in the absence of such animals, the moa excepted, are little protected against their attacks. At the same time, the special equipment of the more aggressive introduced species of plants makes these formidable. Many are annuals—a great advantage for rapid dispersal—whereas almost all the indigenous species

are perennials. Rapid vegetative increase by means of creeping and perhaps rooting stems, the formation of a dense turf, rapidity in germination of seeds, enormous seed-production, special contrivances for seed-dissemination by the wind, tolerance of extreme changes of soil and climate, leaves pressed closely against the ground, deeply descending roots, immunity against attacks of animals afforded by a woolly covering, unpleasant taste, &c., conspicuous flowers for insect fertilisation—all these and other beneficial characters are frequent amongst the acclimatised species.

A plant may remain quite isolated for years and be apparently incapable of spreading, but an unlooked-for change of conditions may give it just what it requires. Dr. Truby King pointed out to me a most interesting case. At Waitati, on the land belonging to the Mental Hospital, stands a fine example of the stringy-bark (*Eucalyptus numerosa*) more than fifty years of age. Originally the vegetation of the place was mixed forest, but this has been replaced by a close growth of manuka heath. Some ten years ago this was burned in the neighbourhood of the tree, and a young forest of gums several acres in extent has sprung up (fig. 59), the new ground and the potash from the fire being eminently suitable for the germination of the gum-tree seeds. At the present time the gum-saplings grow extremely closely. Their height is from 40 ft. to 50 ft. Some are half a foot in diameter, while others are extremely slender. Thousands of manuka seedlings sprang up along with those of the gum; and it must not be forgotten that manuka, far more than most of the indigenous plants, can reproduce itself again and again after burning, and can exclude almost all other vegetation. But in this case the greater rapidity of growth gave the gums the victory, and now only a little manuka remains near the margin of this remarkable and quite natural forest-growth. Nor is the above merely interesting biologically: it is equally important from the point of view of cheap afforestation of unproductive areas covered with manuka heath.

The replacement of the native species by aliens has wrought a remarkable alteration in the appearance of New Zealand. Gone from vast areas is the magnificent tropical forest; vanishing in many places are even the alpine plants. Fortunately, some time ago the Government took the matter in hand seriously, recognising that as the indigenous vegetation is one of the great attractions of the Dominion, it should be, in certain places, kept inviolate. And so many small

reserves have been proclaimed, and various extensive national parks and special sanctuaries have been set aside. This has been an admirable national work, but it is needful to see that typical examples of the various plant societies are preserved. A plant society, as shown in an earlier chapter, is something distinct in itself, and it is the special combination of plants rather than the individual species which dominate the scenery of New Zealand, giving it its peculiar character. Were the protection of the species themselves all that

FIG. 59. — Spontaneous growth of an Australian Gum (*Eucalyptus numerosa*), which has taken the place of Manuka heath by help of fire. Waitati, Otago. [Photo, L. Cockayne.

was desired, then they might well be collected in botanic gardens, and the whole length and breadth of the land turned over to flocks and herds and fires, becoming on barren ground hot-beds of weeds, unprofitable for farming. How this can happen is to be seen only too well on our river-beds, where gorse, broom, and sweet-briar reign; or on unused bush-clearings, where the Californian thistle alone flourishes.

From what has gone before it must not be inferred that the acclimatised vegetation has no esthetic value. Highly cultivated lands, with their green meadows, waving grain, and stately plantations of foreign trees, are delightful. The gorse, noxious weed though it may be proclaimed, is a glory when its sheets of gold dazzle the eye. The green lines of self-planted willows on many a river-bank; the yellow lupin of the dunes; blue periwinkles by the roadside; white arum lilies on wet ground in the north; stately mulleins on montane river-beds—these and many more are well worthy of admiration.

A rather curious fact that seems to need explanation is the absence of those hedgerow plants that make delightful the lanes of England. It is not that the prettiest of the flowers of the Mother-land are absent, though many appear to think this is the case. Some perhaps are to be seen only in our gardens—*e.g.*, the wood-anemone, the wild hyacinth, the lily of the valley, primroses, cowslips, the bluebell of Scotland or harebell, and the daffodil. But the germander speedwell, the herb-robert, deadnettles white and pink, daisies, buttercups, the ragged-robin, the stonecrop, wild roses, blackberries, the honeysuckle, the forget-me-not, the toadflax, the bird's-foot trefoil, the dog-daisy, the bugloss, and the foxglove, to mention only a few British plants, are now wild in various places. The fact is, our hedges are frequently of gorse, a plant which smothers out most herbs with which it comes in contact. Introduced grasses also grow with a vigour unknown in Europe, and will not permit such plants as the primrose to become established. Cattle, too, graze by the roadside. In short, the conditions are quite different from those afforded by the mixed hedges of the Old Land.

No further details can be given regarding individual acclimatised plants. A full list is given in Cheeseman's excellent Flora (pp. 1063 to 1093), and descriptions of most may be found in any British Flora. For those living in settled parts of the Dominion, where the indigenous plants are scarce, the introduced species will afford much material for profitable study, the purpose of which should be not to find their names merely, but to continue such observations as this and previous chapters may have suggested.

It may be asked whether there may not be introduced some day other plants which might become dangerous pests. So far as animals are concerned, the experience of New Zealand towards acclimatisation has not been encouraging, and it is wise to consider long and care-

fully, and get the best advice available, before turning any animal loose. Doubtless the same reasoning applies to plants; but, unfortunately, they do not wait to be set free. Probably all the worst weeds of the earth have already arrived, and we cannot expect newcomers that would rival the couch-grass (*Agropyron repens*), the sorrel (*Rumex Acetosella*), or the so-called "Californian thistle"* (*Cnicus arvensis*). At the same time, any farmer who sees a new plant on his farm should look at it askance, obtain what information he can get respecting it, and eradicate it at once if he has any reason to suspect it of having the weed-assuming characteristics.

Finally, there comes in the question whether any of the native plants are liable to extinction. Personally, I should answer this in the negative. There is nearly always some haven of refuge, and, though many species will eventually become much more rare, it is most unlikely that any will be entirely eradicated.

* This plant is a native of the British Islands, Europe generally, north Africa, and northern to western Asia. It is only naturalised in the United States, where, however, it is called the "Canada thistle." In England it is known as the "corn-thistle" and "creeping thistle," and is a weed of either cultivated or waste ground.

CHAPTER X.

THE STORY OF SOME COMMON PLANTS.

Relationships of the cabbage-tree—How gravity affects direction of growth—Fertilisation and seed-dispersal—Distribution of the cabbage-tree—Use of the tree in Maori times—The species of *Phormium*—The diverse stations of *Phormium*—Fertilisation by birds—The leaves of New Zealand flax—Use of flax by the Maoris—Garden varieties of *Phormium*—Diseases.

In the previous chapters a general account of the vegetation has been given rather than details as to special plants. In this and the chapter following a few of the commonest plants are dealt with, and something is told of their story, which, however, as yet is far from being a complete one.

The Cabbage-tree.

The cabbage-tree (*Cordyline australis*) is a most familiar feature in almost any New Zealand landscape, while it is also a favourite adornment of gardens, supplying there a special beauty of form generally lacking in the temperate vegetation.

But, although the plant in question is known so well, it may yet be news to some that it is no relative of the wholesome vegetable whose name it bears. It, on the contrary, belongs to the same family as the Madonna lily, the hyacinth, and the tulip; or, if we must seek its relations below stairs, then to the onion, the garlic, and the shalot, whilst amongst its first cousins it boasts such useful members of society as aloes, squills, and sarsaparilla. Now, it is the structure of the flowers which places it in this most distinguished company, the outer floral leaves being united at the base,* but divided above into six segments, the stamens also six in number; while the central portion of the flower, which finally contains the seeds, is three-chambered. At the same time, it differs from most of its kith and kin in its possession of a tall, erect trunk, being, in fact, a tree- or palm-lily, this latter

* The coloured leaves of the flower in the lily family are in two series, and in certain of the genera are not united below into a tube.

designation having been bestowed on account of its tropical-looking habit, for it is not really a palm.

Fig. 60.—Underground stem of Cabbage-tree, with numerous roots.
[Photo, L. Cockayne.

The trunk plays a most important part in the domestic economy of the tree, sending down deep into the ground what is popularly supposed to be a root. This, however, is nothing of the kind, but a deeply descending underground stem, which has the curious property for a stem of growing downwards while the aerial portion of the same trunk grows upwards, as should that of any well-regulated tree (fig. 60). Such growing upwards and downwards of stems and roots is regulated by that force we call gravity, which sets in motion the intricate and powerful "machinery" of the plant, just as a pressure of the hand lets loose that power which causes the mighty locomotive to move backwards or forwards, as the case may be. The descending stem penetrates the soil for a distance of several feet, giving off on either side long cord-like roots, which, passing outwards

and downwards, anchor the tree firmly, so keeping it erect. But the underground stem, besides functioning as a natural prop for the tree, plays a further and more important part, since there is stored up within its tissues the surplus food, manufactured within its green leaves from the carbon-dioxide of the air by the aid of sunlight. On this hoard the tree draws yearly, and the material is lent from which the huge mass of flowers is constructed. Should too much of the starchy food be used, or not enough have accumulated owing to an adverse season, there will be few or no flowers the succeeding year. A sufficient balance must be kept at its bankers, as it were, or its life work will remain undone.

The dead leaves of the cabbage-tree are scrupulously removed every year by the tidy but too zealous gardener, and a long, naked stem results. Nature, however, loves not nakedness in any form—the bare rock she clothes with lichens, and the fallen giant of the forest with moss; so, too, she hides the upper portion of our tree's trunk with a not inelegant covering of brown dead leaves. Nor is she mindful of beauty alone in so doing, for these leaves become saturated with moisture when the welcome rain falls, the trunk on its part putting forth many short but active roots, which must assist the leaves materially to the all-important water-supply in dry weather. As for the leaves themselves, they are provided with a strong, fibrous skeleton, which enables them to defy the frequent gales; also, they are more or less erect, and thus escape the full force of the sun's rays—a decided benefit in the long, hot summer days; and, finally, their minute structure is such as to guard them against excessive loss of moisture in times of drought.

The cabbage-tree blooms during November and December; the flower-stems are much-branched, and crowded with small whitish flowers. These have a most powerful, though rather sickly, odour, which attracts crowds of insect visitors, who in return for the gift of sweet honey assist in bringing the dust-like pollen of the stamens to the stigma, and thus fertilising the egg, which in due course will then grow into a seed—that is, into a small body containing within it a tiny cabbage-tree. The seeds are black in colour, and angular, nine or less being enclosed in the succulent, three-chambered, milky-white berries. These latter are greedily eaten by birds, who thus assist in sowing the seeds far from the parent tree. Not only do the native birds engage in this work, but the introduced ones have learnt also to

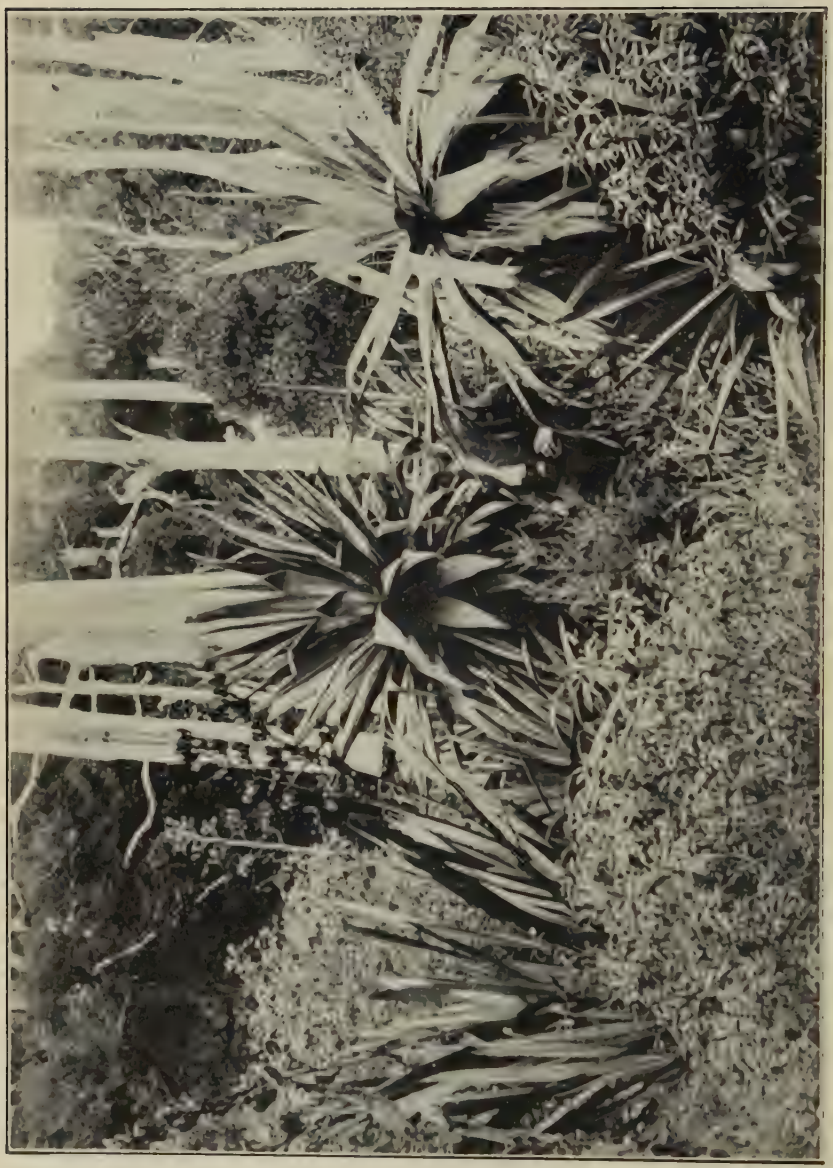

FIG. 61.—The Broad-leaved Cabbage tree, or Ti (*Cordyline indivisa*). Mount Hauhungatahi.
[Photo. L. Cockayne.
Lands Department.]

play their part, and so there is little fear but that the cabbage-tree will always remain with us as a truly wild plant; in fact, in some parts of New Zealand it is on the increase, as in the swampy ground of northern Auckland, where, when the close-ranked kahikatea forest is felled, stately files of this graceful tree rise up in its stead.

The genus *Cordyline* is somewhat widespread, its species being found wild in southern Asia, the Malay Archipelago, the Pacific islands, Australia, New Zealand, and South America. The special species we are considering, *C. australis*, is confined to New Zealand; but, though it is extremely abundant in the two main Islands, and its fruits are readily spread by birds, it is found in only one locality in Stewart Island, and does not occur at all in either the subantarctic islands or the Chatham Islands.

There are four other species of *Cordyline* in New Zealand, one of which, the toi (*C. indivisa*) (fig. 61), is a magnificent object, with its broad, arching leaves furnished with a conspicuous orange-coloured midrib. It is common at rather high levels in the North Island, but descends to sea-level in the South at the Otago Sounds. On the east of the South Island are a few plants on Banks Peninsula. Where the service road to the Main Trunk line has been made along the base of ice-capped Ruapehu, and the forest has been cleared, are splendid natural plantations of this beautiful tree, which grows in some places, indeed, by the thousand.

The common cabbage-tree is easy of cultivation. It will grow in almost any kind of soil, and may be readily raised from seed, this being the best method to secure a stock of plants. When a tree is cut down level with the ground it does not die, but will usually put forth new shoots from the underground stem. Even at an early age it is very ornamental, and young specimens, whose trunks are not yet developed, are eminently suitable for small gardens. There is a purplish-leaved variety, and also one with variegated foliage. Moreover, the cabbage-tree is a variable species, and many forms distinct for garden purposes may be met with in the wild state.

In a land where the natural vegetable products were not of much economic value, the most unlikely plants were pressed into the service of the aborigines, and any possessing the slightest beneficial property were made use of. The cabbage-tree, or, as the Maoris designated it,

the ti, tikauka, or tirahau, served several purposes. The underground stem, since it contained a large supply of starch, supplied a nutritious if not an especially palatable kind of food, and the leaves were plaited into flat or round ropes. In the north, however, *C. pumilio* was much more prized for food. *Cordyline indivisa* was still more esteemed for its fibre, which, according to Colenso, was woven into a durable mat called toii, which was dyed black.

In Europe the cabbage-tree is much prized for horticultural purposes, though it is hardy only in the warmer parts. In the Scilly Isles it is used for hedges, making wind-screens to the fields of daffodils, there grown so extensively for the London market. Strange to say, many New Zealand plants, the cabbage-tree amongst the number, grow luxuriantly in the Isle of Arran, Scotland, which are only half-hardy farther south: a fact which recalls Stewart Island, where in certain parts trees peculiar to northern Auckland are cultivated with success, but which cannot endure the climate of the Canterbury coast.

The New Zealand Flax.

Still more common than the tree just dealt with, and equally well known to all, is the New Zealand flax. This is another misnomer, as popular names usually are, since the species in question is no flax at all, but another member of the lily family, consequently a near relative of the cabbage-tree, the true native flax being a pretty white-flowered herb (*Linum monogynum*) common along the sea-coast. Although still extremely abundant, the flax has much diminished in numbers since the advent of the European, for the simple reason that it occupied the very ground most suitable for agriculture. Where the golden grain waves in the breeze, and where the lamb, unconscious of its doom, crops the lush grass, were formerly vast swamps, closely filled with the gigantic sword-like leaves of the plant, beneath whose friendly shelter countless red-legged pukeko sought their food, safe from their dreaded enemy the hawk.

The genus *Phormium*, to which the New Zealand flax belongs, is found only in Norfolk Island and New Zealand, and consists of but two species, *P. tenax* and *P. Cookianum*, this latter formerly known as *P. Colensoi*. These are readily distinguished by their "pods," those of the former species pointing upwards and not twisted, while the latter's droop downwards and are twisted. Further research may

perhaps show that these species are made up of a large number of varieties which produce themselves "true" from seed.

New Zealand flax grows in most diverse stations, and the structure of its leaves probably varies much according to environment. Faces of dry cliffs, clayey hillsides, swamps, and sandhills are some distinct spots where *P. tenax* flourishes. Nor is it fastidious as to climate. The warm valleys of northern Auckland, the wind-swept shores of south Westland, the bleak moorlands near Invercargill, the quaking bogs of the Chatham Islands, all afford it a suitable home. This Chatham Island form is distinct from the typical variety, its leaves being thinner, broader, and drooping, and its fibre comparatively weak, but very fine. There is also a small amount of flax on the Auckland and Campbell Islands; but it is not indigenous, having been planted there by the Maori sealers many years ago.

The flowers of the flax are not very showy, being of a lurid red in *P. tenax* and yellow in *P. Cookianum*. The pollen is usually ripe before the stigma of the same flower is ready to receive it, a fact which points to cross-fertilisation as a possible cause of the great variation of the species. The abundance of honey contained in the flowers attracts the tui and other native birds, who assist in the work of fertilisation, playing the part performed in many plants by insects.

The leaves spring from a short but stout creeping stem, and this latter, spreading over the ground, helps to increase the spread of the plant. It grows readily from seed also; and from the seedlings, if raised in a sufficient quantity, new varieties might be expected.

The leaves are stout and thick, and stand erect, thus avoiding the direct rays of the sun—a contrivance against loss of water, as shown before. That a swamp plant should require protection against drought seems absurd, but this special drought-combating structure it is which permits the plant to inhabit rocks, dunes, and other excessively dry stations mentioned above. Nor does it seem unlikely that the flax has been driven into the swamps by its competitors, and lives there not from choice, but from necessity, though its drought-resisting structure is no longer an advantage, unless the water of the swamp be acid.*

* See remarks on physiological dryness in Chapters V and VII.

The harakeke, as the Maoris call the flax, was their most important plant, for on it their supply of clothing almost entirely depended. Dress mats of great variety were made from its fibre at an infinite expenditure of patience and labour. Some of these were dyed various colours, and were provided with elaborate borders. It also played its part in the Maori pharmacopoeia, being prepared in various ways for external application chiefly. From the dry flower-stalks, the korari, the Morioris of the Chathams built their fragile canoes.

Like the cabbage-tree, the flax is an admirable garden plant, and there are a number of very distinct varieties. Of these the principal are various variegated forms belonging to both species. Some, if not absolutely "true" to seed, certainly yield a large percentage of variegated plants; others, again, will put forth green leaves, and finally revert to the type, as did an especially fine specimen the author collected a number of years ago on the flanks of Mount Sherwood, in southern Marlborough. There is also a showy purple-leaved variety, especially striking when young, and a pleasing form with rather bronzy drooping leaves, marked with a dark line on the margin. Beyond the borders of New Zealand the flax is cultivated for ornament in all civilised lands.

The Maoris, too, cultivated the plant to some extent, and gave names to the different varieties. Hector's work, published in 1872, enumerates no fewer than fifty-six. But doubtless many of these are identical, while it is probable that the same name was used by different tribes for distinct varieties; consequently, the Maori names are of little moment. Yet it must be noted that some of the Maori varieties contain a much better class of fibre than that of the average swamp plant.

Botanically, *Phormium tenax* is a most variable plant. The colour of the leaf-margin and midrib, the length of leaf-butt, its interior colour and gum-content, the stiffness of leaf, the breadth of leaf, the form and colour of flower, and the shape, size, and direction of growth of the pod—all these and other characters differ in different individuals. Indeed, it needs a close examination of any specimen and a long experience with flax-variation before one is able to select different varieties from the heterogeneous mass of a phormium swamp.

Phormium tenax, although an indigenous plant, is not immune from " pests " of various kinds, some of which are vegetable and some animal. Circular black spots formed by a microscopic fungus (*Cladiosporium*) cause not only the premature death of the leaf, but also render the fibre discoloured for milling purposes. Leaf-spot is a worse disease still, red discolorations being formed on the surface of the blade. Perhaps the worst enemy of the plant, and certainly of the flax-miller, is an indigenous slug which eats out patches on the under-surface of the leaf. Strange to say, according to the researches of T. W. Kirk and A. H. Cockayne, " these gouged-out portions of the leaves are frequently attacked by a fungus (*Rhizopus nigricans*), but this fungus never seems to attack healthy plants." The leaf-margin is the point of attack of various caterpillars, who cause jagged wounds.

CHAPTER XI.

THE STORY OF SOME COMMON PLANTS—Continued.

Abundance of manuka—Tea-tree or ti-tree ?—Various stations of manuka—The different species and forms of *Leptospermum*—Uses—The fuchsia as a deciduous tree—Object of leaf-fall—The species of *Fuchsia*—Construction of the flower—Contrivances for cross-fertilisation—The wood and its properties.

The Manuka.

The manuka of the Maori, the tea-tree of the colonist, and *Leptospermum scoparium* of the scientist, should also be well known to every reader. Unlike the plants already dealt with, it has not suffered loss at the hands of the white man, but, on the contrary, has become aggressive, and at the present moment occupies more territory than in the pre-European days. This is owing to its power of thriving on any kind of soil, wet or dry, to the great fertility and number of its seeds, and to its habit of blooming at an abnormally early age for a shrub. The blossoms are distinctly showy—a manuka heath in due season being a sheet of snowy whiteness.

The flowers have a five-lobed calyx, the tube of which is attached to the ovary. There are five spreading petals and a great number of stamens. The fruit is a woody capsule containing many seeds, most of which are unfertile.

This structure of the flower shows the shrub to belong to the same family as the myrtle and rata in New Zealand, while abroad it has relatives in the gum-trees of Australia and the clove and allspice of the tropics.

Its leaves are small and stiff, and, like those of the family in general, extremely aromatic. This property has led to their use as a substitute for tea by the enterprising pioneers, who would probably cloak the unpleasant taste by means of no small allowance of sugar. From this use the English name "tea-tree" has arisen, and through corrupt spelling the spurious Maori "ti-tree" has followed, a term beloved of journalists. Worse than this is the usage in South Otago, where, "plain for all eyes to see," is the legend "Ti-Tri" on a certain wayside station.

Like the flax and cabbage-tree, the manuka grows equally well on faces of rocks, in swamps, and on dunes, while in the Hot-lakes District it occupies a more inhospitable station still—the ground charged with chemicals near the boiling pools; in fact, few plants can so adapt themselves to varying circumstances—an important matter when one is concerned with the origin of species. As an example, it may be mentioned that on the central mountains of Stewart Island, where the wind blows with an almost incredible velocity, the manuka has changed its habit altogether, and, instead of being an upright shrub, lies prostrate upon the ground, as a far-spreading mat, its branches even near their apices putting out roots and fastening it to the soil. So different is this from the usual habit of the plant that one could hardly believe it to belong to the same species, were it not for the fact that all kinds of intermediate wind-shorn stages exist within a few feet of one another (fig. 62).

Besides *L. scoparium*, there are at least two other species in New Zealand—one, the tree-manuka or kanuka, a common plant enough; and the other, *L. Sinclairii*, only recorded hitherto from the Three Kings and the Great Barrier Island. The tree-manuka is distinguished from the commoner species by its larger size and its smaller stalked flowers, which are crowded together in great profusion, while the latter has larger, unstalked, solitary flowers. Both are very variable; but the most interesting varieties are those of the common manuka, which exhibit more or less red in their petals. Some are actually bright crimson, at least four such having been found, according to the author's knowledge, in the wild state.

These crimson varieties make beautiful garden plants. One, called by gardeners *L. Chapmani*, has been in cultivation for many years. Another, also with a garden name (*L. Nichollsii*), of more vivid crimson, is still handsomer. This, although introduced only a year or two ago, has already become established in a few English gardens, and is perhaps better known there than in its native land.

None of these red varieties seem to come absolutely "true" from seed, so they must be grown from cuttings, which unfortunately do not root readily. The red colour is present not only in the flowers, but extends to the leaves, which in all these races of manuka are more or less of a purple hue.

FIG. 62.—Effect of Wind on Manuka (*Leptospermum scoparium*). All in foreground is Manuka, as well as the taller plants.

Lands Department.] [Photo, L. Cockayne.

There is also a form of manuka with double white flowers which was discovered a few years ago by Mr. E. Phillips Turner, Inspector of Scenic Reserves, but it has hardly got into cultivation as yet.

The common species of manuka are not nearly so much cultivated in gardens as they deserve. Not only are they extremely beautiful when in flower, but they will grow well in any kind of soil. Young plants may be procured from any heath in abundance, or raised from seed, which germinates readily.

One of the mistletoes is very frequently parasitic on *Leptospermum scoparium*. It is a very small shrub with curious jointed stems, but no leaves. It rejoices, or perhaps the contrary rather, in the name, much bigger than itself, of *Korthalsella salicornioides*. When this parasite becomes too abundant, the drain on the "life-blood" of its host becomes too great, and the branch supporting the mistletoe, or even the shrub as a whole, will die.

The common manuka (*L. scoparium*) has not usually a trunk stout enough to be of much use commercially, but it affords excellent firewood. It is also frequently used for brush fences, for the walls of whares, and for brooms, while the long straight poles are valuable for various purposes in gardens.

The colour of the wood differs in the two species. This has led to *L. scoparium* being called "red" and *L. ericoides* "white" tea-tree. As the leaves of both species are distinctly aromatic, a fragrant oil, which might possess medicinal properties, could be distilled from them.

The timber of the white tea-tree (*L. ericoides*) is of greater value than is that of its smaller relative. It has been used for wheelwrights' work, house-blocks, piles for small jetties, and fencing purposes. It also is highly valued for firewood.

The genus *Leptospermum* is made up of about thirty species, extending from New Zealand in the south to the Malay Archipelago in the north, by way of Australia and New Caledonia. By far the greatest number of species are Australian.

The Native Fuchsia.

There is hardly a forest in New Zealand, either primeval or almost obliterated, where the native fuchsia, the kotukutuku of the Maoris, with its thick irregular trunk and hanging strips of brown and papery

bark, may not be seen. Should the time be winter, then will the tree be leafless; but if summer, then there will be abundance of soft, thin leaves, green above, but beneath pale and silvery.

The deciduous habit is very rare amongst New Zealand plants, being confined to two or three, for naked boughs in winter are in harmony with a cold and frozen soil, since roots cannot suck up water if it be too cold, and the presence of leaves under these circumstances would be worse than useless. But where the climate is mild and equable, as in this country, then there is no need for leaves to fall, since they can do their complex work more or less efficiently all the year round. The fall of the fuchsia's leaf was not unnoticed by those keen nature-students, the ancient Maoris. "Where wast thou at the fall of the kotukutuku?" would be demanded of the laggard who had been absent when his presence was urgently needed during that special season of labour, the planting of the kumara.

The genus *Fuchsia* derives its name from a German botanist, Leonhard Fuchs (*Anglice*, Fox), who lived during the early half of the sixteenth century. It contains more than fifty species, which, with the exception of three New-Zealanders, are all South Americans. From certain of these latter have been raised by the gardener's skill the large-flowered and brilliantly coloured varieties so popular in gardens.

The New Zealand species consist of the tree mentioned above (*F. excorticata*); a shrub, or at times a scrambling-liane (*F. Colensoi*); and a rather rare trailing or partly climbing sea-shore plant, found only in the north of Auckland, but not uncommon as an ornamental pot-plant (*F. procumbens*). The last is distinguished from the other two by its erect flowers and its very large and extremely handsome red berries.

The flowers of *Fuchsia excorticata* are produced very early in the year, and some even before the tree is in leaf. The calyx, green and unattractive in most flowers, forms here the conspicuous part of the blossom. Below, it is attached to the ovary; then it is constricted, and finally expanded into a funnel-shaped tube, which is divided at its margin into four acute segments. The colour is green and purple, but it soon fades into a dull red. The petals, four in number, are inconspicuous: they are inserted at the throat of the calyx. There are eight stamens. The style is slender and elongated, and terminates in a little knob, the stigma. The pollen is of a blue colour, and adds

to the attractiveness of the flower. It is also extremely viscid. Both stamens and style are very variable in length; and thereby hangs a tale, which as yet can be only half told.

This variability in length of style and stamens leads to there being three forms of flowers, which may be distinguished as—(*a*) the *long-styled*, where the stigma projects far beyond the mouth of the funnel, within which the stamens lie hidden; (*b*) the *short-styled*, where the filaments are long, and almost equal the quite short and but slightly projecting style; and (*c*) the *mid-styled*, which is a form intermediate between the other two.

These different forms of flower are not without an object. Experimentally it has been found that in many cases it is advantageous for a flower to be fertilised with pollen other than its own, and ample provision is made in nature for such cross-fertilisation,* as it is called. In the case of *F. excorticata* the pollen of the long-styled form is usually immature or wanting—in other words, the flower is a female one. On the contrary, the short- and mid-styled flowers produce an abundance of serviceable pollen. The transmission of the pollen from one flower to another, so frequently the work of insects or the wind, is here performed by birds, especially the bell-bird and tui, whose heads become dyed blue with the sticky pollen as they pass from blossom to blossom in their greedy eagerness for the honey therein contained. The birds' work in time becomes manifest, through the long-styled flowers producing berries; whereas the short- and mid-styled flowers appear to be incapable of fertilisation from their own pollen, and bear but few berries. The above are the general details as stated in the "Forest Flora"; but the whole matter requires fresh investigation, and especially experiments conducted regarding the powers of self-fertilisation of the short- and mid-styled flowers.

The fruits of the fuchsia are a favourite food of the pigeon and kaka, and the seeds are distributed far and wide by these birds. They are insipid, but not unpleasing, especially to a youthful palate. To the Maori they were a welcome change of diet in a country devoid of luscious fruits, and a special name, "konini," was applied to them.

The timber of the fuchsia is almost indestructible. It is extremely strong and tough, but the gnarled trunk is of little value commercially.

* See also Chapter III, *re* fertilisation of flowers.

It is, however, an ornamental wood, and can be used for inlaying and turnery. As a firewood its badness is almost incredible, and truly none but the newest of chums would dream of using it when camped in the forest. "Bucket-of-water wood," it has been termed; and the rather tall story goes how a trunk, which had been used for a back log to a fire for a whole year, upon being finally cast into the open air as worthless, put forth green shoots, and grew again into a tree!

As a garden plant *F. excorticata* is not unpleasing; but for a small garden *F. Colensoi* is more to be recommended. Neither species will tolerate much frost, although *F. excorticata* is abundant in the cold mountain districts of the South Island. There is a distinctly handsome form with purple leaves; but this is rare, and only in cultivation in the gardens of one or two enthusiasts.

CHAPTER XII.

THE CLASSIFICATION OF THE PLANTS.

Popular plant-names and their defects—Advantage and meaning of scientific names—Explanation of terms "genus" and "species"—Principal divisions of the plant kingdom—Rapid glance at the families and genera of New Zealand flowering-plants—Ferns, mosses, fungi, and algae—The slime fungi partly animal, partly plant.

Popular Names.

Certain New Zealand plants possess two kinds of names—popular and scientific. The former are either English or Maori. The English names are for the most part those which have been given by the early settlers, partly from some likeness, real or fancied, to the plants of their native land, and partly from some peculiar characteristic of the species in question. To this latter category belong such names as lacebark, ribbonwood, spiderwood, milk-tree, pincushion-plant; and to the former, birch, ash, honeysuckle. Some names have been bestowed for jocular reasons—*e.g.*, lawyer, wild-irishman, spaniard, and nigger-head. Finally, a few are the work of botanists who have sought, vainly for the most part, to bring into use a nomenclature that should have a more correct English equivalent for the scientific name—*e.g.*, speedwell for *Veronica*, groundsel for *Senecio*, palm-lily instead of cabbage-tree, beech instead of birch, &c. Some English names are corruptions of Maori ones, as biddy-biddy for piripiri, cracker for karaka, maple for mapou. This origin of names is quite an interesting study in recent word-making, and is well worth investigating.

The Maoris, living as they did in constant touch with nature, possessed much more knowledge of the vegetable products of New Zealand than do most of their more enlightened, but in some respects degenerate, white brethren. For all the more common trees and shrubs the Maoris have names. But both Maori and English names are used loosely, some being applied to more than one species, or having a different signification in different districts. Akeake is applied to *Dodonea viscosa*, *Olearia Traversii* and *O. avicenniaefolia*; koromiko

is the name for several species of *Veronica ;* toetoe is the name for a large number of grasslike plants, and totara for the lofty taxad equally with the dwarf heath *Styphelia Fraseri.* Other instances could be given, but these will suffice. Further, many plants have neither a Maori nor an English name. From the above it may be seen that the popular names are of no use when we wish to make an accurate list of even the seed-plants of any locality, and that names having a definite application must be used. For this reason the scientific names have been designed.

Scientific Names of Plants.

The scientific names are in Latin. The use of Latin among learned men dates, of course, from the time of the Romans ; but its application to plants, as we now know them, began in the sixteenth century, when modern botany was born. Latin was then the universal written language of the learned, and the early botanical works were all written in that tongue. This usage of Latin has proved very convenient in practice, for it would lead to endless confusion did the plants bear the popular names of their respective countries alone. As it is, a definite scientific name is applied to one particular species, and to that only, and such names are recognised by scientists, no matter what their nationality.

Each scientific name consists of two words, the first denoting what the genus is, and the second the species to which the plant belongs.

Meaning of Terms "Species" and "Genus."

To write down the word "species" is much easier than to define what a species really is. In fact, when it comes to fixing the limits of a species, scarcely two classifiers can agree. Elementary species, as defined by De Vries (see Chapter I), are the units of the plant kingdom. Such are those groups of plants which differ from all others in certain distinct characteristics, and reproduce themselves "true" from seed. But this experimental method of separating species is not yet in vogue, nor does it seem altogether practicable.

The species, then, of the classifiers are founded by the comparative study of large numbers of individuals, and if a group of such has some distinguishing characteristics which separate it from all other groups of individuals, it is classed as a species. Such a group of individuals may form a true species, which will reproduce its kind,

or it may be made up of a number of elementary species. Thus the species of the botanist are by no means equal in value. In practice, however, if a number of plants resemble one another almost exactly, they may at once be concluded as belonging to the same species.

If a number of species agree in certain particulars so that we may conclude they have descended from some common ancestor, they are said to belong to the same genus, and we have the next wider group of plants. Suppose we find a number of plants which, although they differ much in stature, shape of leaves, habit of growth, size and colour of flowers, and in other particulars, yet have all four petals, eight stamens, the calyx-tube attached to the ovary, and produce after flowering a narrow, elongated, 4-angled capsule, which splits open from the apex downwards into four sections, revealing a large number of seeds, each provided with a tuft of hairs at the apex, then all those plants will belong to the genus *Epilobium* (fig. 63). These plants, again, will vary much amongst themselves ; but groups having distinguishing marks for each group can be found, and such groups will each represent a species. There are in New Zealand between thirty and forty species of *Epilobium*, which are distinguished from one another by distinctive marks, and each bears a name—*e.g.*, *Epilobium glabellum*, *E. Hectori*, *E. pubens*, &c.

Originally the second name had a meaning which was supposed to be appropriate to the plant, but the number of specific names has so increased during the past hundred years that it is no longer possible always to find an appropriate appellation. So modern botany has decreed that a specific name once given must stand for ever, even where the name is quite inappropriate. This means that a name is now considered merely as a name and nothing more, and need have no meaning whatsoever.

Another matter which must be remembered is that generic differences generally depend on the structure of the flowers, and not on the leaves. That a plant has leaves like a willow does not constitute it a willow ; similar plant-form, as has been already shown in this book, occurs amongst plants quite unrelated. Leaves, however, amongst other characters, are made use of as marks of specific differences.

Finally, before leaving this matter of names, it must be pointed out that the naming of plants is merely a preliminary, though necessary, study of the flora of a country. A man might easily know the

names of thousands of plants and be able to recognise the species at a glance, but he would be no more a botanist than would another man be an engineer who knew only the names of different kinds of engines and their parts, but who was quite ignorant of their construction and

FIG. 63.—*Epilobium chloraefolium.*

[Photo, L. Cockayne.

management. On the other hand, a man might know the names of hardly a dozen plants and be a botanist of note.

Classification goes still further. A number of related genera make a family, and so on, until such fundamental divisions of the plant

kingdom are reached as—slime-fungi, algae, fungi, liverworts, mosses, ferns, conifers, seed-plants with one seed-leaf in the seedling, and seed-plants with two seed-leaves in the seedling.

The families are now most frequently arranged according to the manner in which they are supposed by some to have originated, the more simple coming first and the more complex last. Thus, amongst seed-plants the pine-tree family begins the list, and the daisy family completes it.

Considering the seed-plants alone, New Zealand has between fourteen and fifteen hundred species, about three-fourths of which are found nowhere else, the number varying according to the computer's conception of a species. Cheeseman gives 1,415 as the number, but the writer's estimate is somewhat higher.

It would be out of place to go at any detail into the families and genera, so only a few of the more interesting are mentioned. Neither can any attempt be made to define the families, &c., in popular language—a task of extreme difficulty, and, when accomplished, harder for the beginner to understand than would be his learning the necessary technical terms, which have a definite meaning and can be used with precision.

The Families and Genera.

The daisy family (*Compositae*) is the largest of our families. What is popularly called the flower is not so, but is really a collection of small flowers placed closely side by side upon the expanded summit of the flower-stalk, and forming a "head." The cotton-plants, or mountain-daisies (*Celmisia*), the groundsels (*Senecio*), the vegetable-sheep and its relatives (*Raoulia*), the cotulas and the helichrysums belong to this order. Many are amongst the most striking of our plants, both in form and flower.

The bluebell family (*Campanulaceae*) has not many representatives with us. It contains the New Zealand bluebell (*Wahlenbergia saxicola*), whose white or bluish flowers are so conspicuous a feature of the upland meadow, and the pretty white pratias which are related to the well-known lobelia of gardens.

The madder family (*Rubiaceae*) contains the large genus *Coprosma*, which is closely related to the coffee-plant. Coprosmas can always be recognised by the male and female flowers being on different plants, and by the berry-like fruit containing two plano-convex stones.

C. grandifolia has very large leaves and reddish-orange drupes, and is common in North Island forests, and extends south as far as Greymouth and Kaikoura. *C. Petriei* forms a close turf in the drier South Island mountains, and has large port-wine-coloured drupes, which occasionally are white and translucent. Many coprosmas are shrubs of a dense habit of growth, with slender interlacing branches.

The figwort family (*Scrophularinaceae*) contains the very large genus *Veronica* and other genera of showy plants (*Ourisia*, *Mimulus*, *Euphrasia*, &c.).

The convolvulus family (*Convolvulaceae*) contains the beautiful climbing-convolvulus (*Calystegia tuguriorum*) and the lovely purple *Ipomaea palmata* of the shores of northern Auckland.

The borage family (*Boraginaceae*) comprises the forget-me-nots.

A little lower down the scale come the gentians (*Gentianaceae*). Owing to the bitter principle in their roots, these plants are not relished by stock. Possibly the root could be used as a tonic, like that of the European *Gentiana lutea*.

There is only one plant of the primrose family (*Primulaceae*), *Samolus repens*, a prostrate, white-flowered plant forming broad patches in salt meadows.

The heath family (*Ericaceae* and *Epacridaceae*) is important, as it contains many common shrubby plants. *Dracophyllum*, with needle-like leaves, and *Gaultheria*, with lily-of-the-valley-like flowers, are the most important genera.

The carrot family (*Umbelliferae*) is well represented, and contains one of the most remarkable genera of the flora, *Aciphylla*.

The willowherb family (*Onagraceae*) is represented by the large genus *Epilobium*. The species are not yet well known, and they are difficult for a beginner to determine. Some are distinctly pretty—*e.g.*, *E. pallidiflorum*, *E. macropus*, *E. vernicosum*. Others become terrible weeds in an alpine garden—*e.g.*, *E. nummularifolium*, *E. linnaeoides*. The fuchsias belong to this same family. Other related plants, though belonging to a different family, are the myrtles and ratas, both of which include some beautiful species—*e.g.*, *Myrtus bullata* and *Metrosideros lucida* (*Myrtaceae*).

The mallow is a very showy family (*Malvaceae*), and contains some small trees most valuable for garden purposes, as the lacebarks and ribbonwoods.

FIG. 64.—Cushion of *Carmichaelia Enysii* var. *orbiculata*. Growing on it is *Celmisia spectabilis* and the Grass *Danthonia semiannularis*. Tongariro National Park. [Photo, L. Cockayne.
Lands Department.]

To the *Elaeocarpaceae* belongs the native currant (*Aristotelia racemosa*), one of the "fire weeds" of New Zealand—*i.e.*, a plant which comes up abundantly after a forest is burned. Here also comes that fine tree the hinau (*Elaeocarpus dentatus*) and the pokaka (*E. Hookerianus*), with its distinct juvenile and adult forms.

The New Zealand geraniums belong to the family *Geraniaceae*. They are generally rather insignificant, though their first cousins the pelargoniums of gardens, incorrectly termed geraniums, are amongst the most showy of plants.

To the pea family (*Leguminosae*) belong the New Zealand brooms (*Carmichaelia*) (fig. 64), of which there are nineteen species, all of which have remarkable contrivances against drought. Here also comes the yellow kowhai (*Sophora microphylla* and its allies), and a rare mountain-plant, *Swainsona novae-zelandiae*, of Australian affinities. Then there is the parrotbill (*Clianthus puniceus*), which is related to Sturt's desert-pea of central Australia.

The rose family (*Rosaceae*) lacks in New Zealand the true roses, but is represented by the genera *Rubus* (five species or more), to which belongs the bush-lawyer; *Geum* (six species, all but one mountain-plants); *Potentilla* (one species); and *Acaena*, to which belong the species of piripiri—plants very unlike roses.

The pitchy-seed family (*Pittosporaceae*) is common in all our forests. The genus can be recognised by the large capsules, which, when they open, contain black seeds imbedded in very sticky matter. *P. tenuifolium*, so largely used as a hedge plant, is wrongly called matipo by the gardeners, which is the name for various species of *Suttonia*.

Saxifrages (*Saxifragaceae*), plants so essentially alpine, are wanting in New Zealand; but we have some forest-trees belonging to the family *e.g.*, the putaputaweta (*Carpodetus serratus*). *Weinmannia racemosa*, called red-birch in Westland, is very common, and belongs to the *Cunoniaceae*, a most closely related family.

The sundews (*Drosera*) belong to the family *Droseraceae*. There are six New Zealand species in the genus.

The magnificent magnolias of America and Asia (*Magnoliaceae*) are absent from our forests, their representatives being shrubs with rather insignificant flowers, the pepper-tree (*Drimys axillaris*, *D. colorata*, *D. Traversii*), a relation of the well-known Winter's bark of South America.

The buttercup family (*Ranunculaceae*) contains, besides the buttercups, of which there are about forty New Zealand species, the charming clematises (fig. 65), and an alpine genus (*Caltha*) containing two species, which have a most curiously lobed leaf.

FIG. 65.—*Clematis afoliata.* [Photo, J. Collins.

The mustard or cabbage family (*Cruciferae*) are mostly plants with rather insignificant flowers. *Lepidium* is the most important

New Zealand genus, and *L. oleraceum*, Cook's scurvy-grass, the most celebrated plant.

To *Loranthaceae* belong the mistletoes.

The nettle family (*Urticaceae*) is distinguished by the appropriately named shrubby nettle, *Urtica ferox*.

The beeches (*Fagaceae*) have been noted when dealing with the beech forests in Chapter III.

To the pepper family (*Piperaceae*) belong the kawakawa (*Macropiper excelsum*) and the succulent herb *Peperomia Endlicheri*.

Among the seed-plants which have only one seed-leaf in the seedling comes the important family of orchids (*Orchidaceae*), of which we have between fifty and sixty species, some few of which live upon trees and have aerial roots.

To the iris family (*Iridaceae*) belong the pretty and easily cultivated libertias.

The lily family contains the palm-lilies (*Cordyline*, cabbage-tree), and the New Zealand flax, of which there are two species, *P. tenax* and *P. Cookianum*, as already noted.

The palm family (*Palmae*) has two representatives—the nikau (*Rhopalostylis sapida*), and one found only on the Kermadec Islands, in the New Zealand region, but extending to Norfolk Island, *R. Baueri* by name.

The rush family (*Juncaceae*) is an extensive one, consisting of the alpine or subantarctic *Rostkovia*, the true rushes (*Juncus*), and the wood-rushes (*Luzula*).

The sedge family (*Cyperaceae*) contains many genera, some of which are frequently mistaken for rushes and others for grasses. Rushes, however, have flowers with small but distinct outer leaves; grasses have hollow jointed stems and leaves with split sheaths; and sedges, &c., have solid stems, frequently angular, and the leaf-sheaths not split.

The grasses (*Gramineae*) are almost the most important natural order, for their economic value cannot be overestimated. Some of the species are of extraordinary size—*e.g.*, *Arundo conspicua*, *Danthonia Cunninghamii*, and *D. antarctica*, this latter belonging to the subantarctic islands. Others are extremely minute, as *Agrostis muscosa*, which forms small cushions on bare, wet ground in the subalpine and montane regions, and even occurs at sea-level in some places.

The pine-trees, belonging to two families (*Pinaceae* and *Taxaceae*), conclude the seed-plants, and differ from all treated of above in that the ovules are naked and not enclosed in a closed chamber (ovary). The most curious of our taxads is *Phyllocladus*, whose "leaves" are really flattened stems, which in appearance exactly resemble leaves. True leaves, however, are to be seen on seedling plants.

The Lower Plants.

The seed-plants do not by any means comprise the whole of the New Zealand flora. There are, for example, more than a hundred and fifty species of ferns and their allies, including one genus, *Loxsoma*, peculiar to New Zealand.

Ferns differ greatly in their form and the texture of their leaves. Some possess two different kinds of leaves—namely, those which bear spores and those which do not, the latter having generally a larger area of surface. The genus *Blechnum* is especially distinguished by its two forms of leaves. Generally the leaf-surface is more or less vertical; but in *Gleichenia* it is horizontal, whence the species of that genus get the name of "umbrella-ferns" (fig. 66). To the genera *Hymenophyllum* and *Trichomanes* belong the beautiful filmy ferns. The leaves of these ferns are generally much divided, but those of the kidney-fern (*Trichomanes reniforme*) are entire. This fern, notwithstanding its thin leaves,* often grows in remarkably dry stations, as on Rangitoto Island, near Auckland City.

The mosses and liverworts embrace hundreds of species living under all kinds of conditions, and varying in size from the giant *Dawsonia superba*, 2 ft. or more tall, to tiny species of liverworts (*Frulania*, &c.) clinging to the bark of trees. Very interesting is the way in which both mosses and liverworts build up great cushions in stations where the air is almost constantly saturated with moisture. In the forests of Stewart Island, but chiefly in the south and west, the cushions look just like moss-covered boulders (fig. 67).†

Low down in the scale of plant-life come those most wonderful plants, the fungi, whose life-histories are as marvellous as any fairy tale, and of which little or nothing was known fifty years ago. Now

* It has thicker leaves than the other filmy ferns.

† Moss-cushions are frequent in the subalpine zone on the west of the South Island. On Mount Rochfort, near Westport, the moss-cushions are magnificent

their study is of the highest economic importance, and plant pathologists are employed by all progressive countries. One example of a New Zealand fungus must suffice. In the *Nothofagus* forests the boles of the larger trees are covered in many instances with a thick coating of a coal-black hue, which gives the trunks the appearance of having been plastered thickly with soot, and tends to enhance the gloomy character of the interior of these forests. This coating consists of a fungus, *Antennaria* by name, which is especially interesting from the manner in which it gets its food-supply. *Antennaria* belongs to the

FIG. 66.—The Umbrella-fern (*Gleichenia Cunninghamii*).
Lands Department.] [Photo, L. Cockayne.

group of "honey-dew fungi," so named because they utilise as food the exudation excreted by certain insects. If a piece of the plant be examined carefully, there will be found imbedded in its interior numerous reddish insects somewhat resembling tiny wood-lice, surrounded with white fluffy material like cotton-wool. These are scale-insects related to the well-known *Coccus cacti*, from which the colouring-matter cochineal is made. This beech-coccus exudes considerable quantities of a sweet sticky fluid, on which the black fungus feeds;

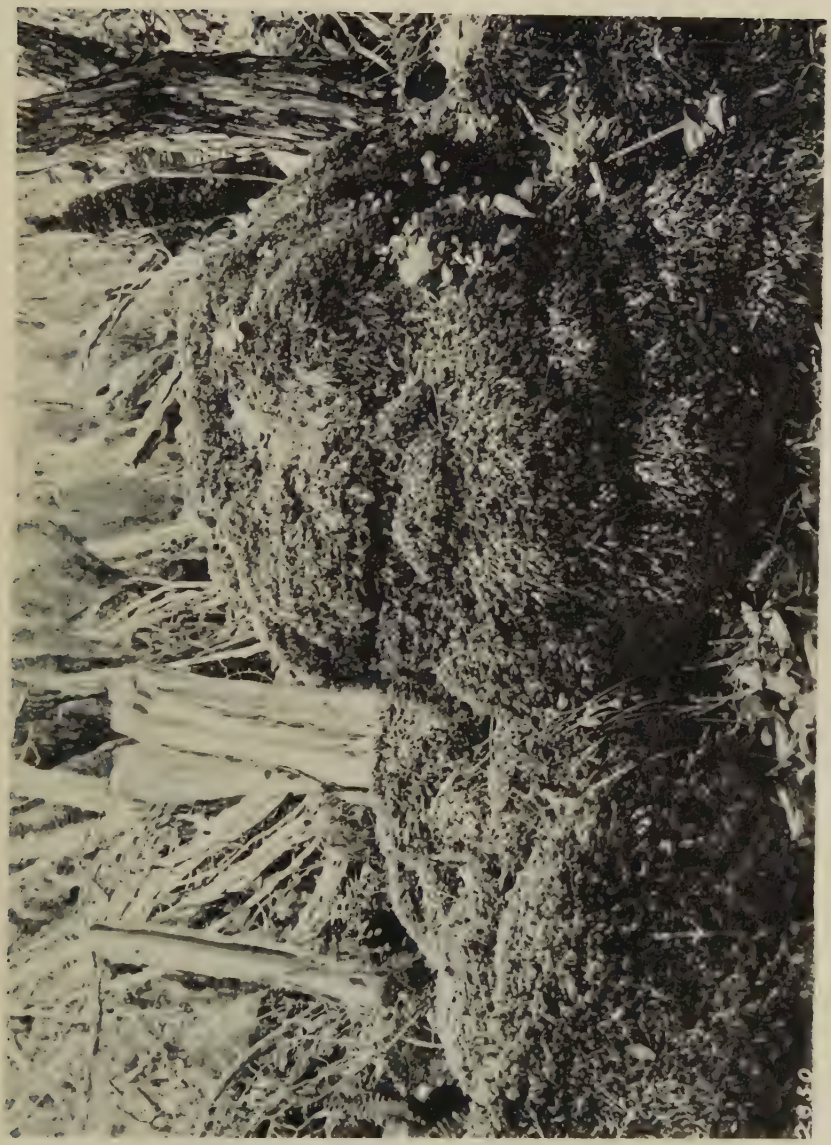

FIG. 67.—Cushion of the Moss *Dicranoloma Billardieri*, 2 ft. 4 in. tall. Mount Rakiahua, Stewart Island.
[Photo, L. Cockayne.
Lands Department.]

while at the same time the scale-insect lives warm and snug under the protection of its sooty covering. *Antennaria* can also exist without its animal lodger and the rent which it pays in kind, but in this case I have been informed that the fungus changes its habit of growth somewhat in accordance with its altered circumstances.

After the fungi come the algae, salt water and fresh. *Macrocystis*, a brown seaweed, attains an enormous size, and lengths of many hundreds of feet are not unknown; indeed, this plant may be the famous "sea-serpent."

Then we have the bacteria—the "microbes" of the newspapers—all infinitesimally minute plants; some the greatest of benefactors, and others the deadly enemies of mankind. And finally come the slime-fungi (*Myxomycetes*), which may be seen as masses of jelly on rotten wood, and which, moreover, are at one period of their existence animals, and at another plants!

CHAPTER XIII.

THE CULTIVATION OF THE PLANTS.

Indigenous plants suitable for school-grounds—Difficulty of growing native plants much exaggerated—Methods of collecting and propagating—Plants suitable for growing from cuttings or from seeds—The school-garden—List of native plants suitable for schools—Cultivation of alpine plants—List of easily grown alpines.

That the plants of New Zealand afford rich material of a most varied kind for nature-study in our schools should be fairly manifest to readers of the previous chapters. Many facts, of course, can be best learnt in the field; but most of the centres of population are far from the virgin vegetation, while the plants of the neighbourhood will generally be interlopers from abroad. In order, therefore, to become really familiar with the indigenous plants, and to watch them at various stages of growth and at all seasons, they must be cultivated; and almost every school in the Dominion might have, at any rate, one bed, even if quite a small one, of the native plants. The gums, oaks, "macrocarpas," and other foreign trees now grown for shade or ornament in the school-grounds may be seen everywhere, and each school throughout the land might gradually replace or supplement them by those New Zealand trees best suited to the particular locality. Thus would the schools as a whole become sanctuaries where the native plants, one of the peculiar features and special glories of the land, would be safe for all time.

But it may be urged that such planting would not be feasible, since every one knows "the native plants are particularly difficult to grow, and when removed from their home in the forests or elsewhere will die." Such an opinion, although widespread, is quite erroneous. It is the rough treatment so frequently accorded to the specimens, first on their being collected, and afterwards when planted, that causes failure, and not any special difficulty in their cultivation; indeed, many are quite as easy to grow as the rank and file of garden plants.

There is no reason why, for instance, the kowhai, manuka, lacebark, ribbonwood, lancewood, totara, large clematis, *Coprosma robusta*,

kauri, pittosporums, and various other forest-plants, as well as almost all the members of the subalpine scrub, should not be cultivated almost anywhere. The mistake so frequently made is to attempt the impossible—*i.e.*, trying to grow a plant in a climate quite unsuitable. It is unreasonable, for example, to expect that the majority of lowland North Island trees can be grown in Canterbury, Otago, and Southland, just as it is hardly wise to try to cultivate plants of alpine and subantarctic meadows in the hottest or driest localities.

For the successful cultivation of many of our plants no particular soil or situation is required. Perhaps, on the whole, a slightly shady position is best. It is well, too, to have some shelter against high winds, especially at first. Such shelter can be supplied by certain indigenous trees—*e.g.*, species of *Pittosporum*, *Olearia Traversii*, *Senecio rotundifolius*, *Coprosma Baueri* (not hardy everywhere), *Coprosma robusta*, and *Veronica elliptica*. Of course, an accurate knowledge as to the situation in which a plant grows naturally is of extreme value, and the method of studying the plant societies adopted in this book is of moment in this respect. But this is not all. It must have been seen by the reader that one particular species may grow in most diverse stations, and that another may grow in a wet place which is physiologically dry. For instance, because a plant grows in a sphagnum bog, it would not necessarily be wise to plant it in a very wet part of a garden. To attempt to grow the lovely *Olearia semidentata* of the Chathams in such a place would be to court disaster; it must be grown in well-drained ground where there is good shelter. Nor because the great forget-me-not of the same group is a sea-shore plant need one despair to cultivate it inland. In short, an acquaintance with natural conditions combined with experimental planting is a necessity for a full knowledge as to the cultural requirements of our plants.

Methods of Propagation and Collecting.

Quite a number of New Zealand plants can now be procured cheaply at some of the nurseries, and from such many will obtain what they may require. However, there will always be some who prefer to collect what takes their fancy in the forest, on the hillsides, or elsewhere. This, as well as being a healthy and delightful occupation, will stock a garden with mementos of many a happy hour, and will recall scenes of beauty.

As to the digging-implement, something light, strong, and easily carried is required. For many years the writer has used a shingling-hammer with the head beaten out into a small pick-axe, a tool first designed by the late Mr. H. J. Matthews. By means of this the strong-rooted plants of an alpine meadow may be attacked, large stones cleared away, and so on. Within the forest, small seedling trees and shrubs are in plenty. But, rather than secure those of the forest-shade, procure those of the outskirts, which are exposed to more sun and wind ; and in such a situation the majority of the forest trees and shrubs, from the lordly kauri to the wiry-twigged coprosmas, may be found, while the smaller the plants are the better. These, when dug up, should be quite freed from soil, nothing being gained by taking up great pieces of earth. The roots should next be closely wrapped round with wet moss, using bog-moss for preference. Alpine plants, too, can be mossed similarly. Finally, to save room and conserve moisture, a number of such plants can be tied into one bundle, the mossed roots being all together. It is astonishing how long plants will remain in good condition if treated in this manner.

These collected plants, upon being brought home, should be planted in boxes or potted, or put into nursery-beds in a shady part of the garden. Of course, if there is a greenhouse, frame, or, better still, a shade-house or plant-protector fitted with a blind, into one or other of these the boxes or pots should go. Some species, difficult to grow from seed or to strike from cuttings, are best collected in their habitats —*e.g.*, many alpine herbaceous plants and subshrubs, various species of *Dracophyllum*, orchids of all kinds, *Gunnera*, *Dacrydium laxifolium*, the various beeches, and the species of *Gaultheria*. Cuttings in many instances will serve as well as if not better than young plants. The following may be propagated in this manner : *Veronica*, *Olearia*, *Senecio*, *Cassinia*, *Aristotelia*, *Myrtus*, *Griselinia*, *Rubus*, *Podocarpus totara*, *P. nivalis*, *Gaya*. Cuttings are best taken in the autumn, and should be struck in coarse sand in a shady place. If placed in pots or pans, those pieces pressed against the edge of the pot have the best chance. They can be struck also in a shady, some even in quite a sunny place in the open. The ground should be kept damp, but not sodden with water.

Most New Zealand plants suitable for gardens can be raised from seed. This should be as fresh as possible. Species of the following

genera usually germinate with great ease: *Sophora*, *Carmichaelia*, *Veronica*, *Epilobium*, *Pittosporum*, *Melicytus*, *Pennantia*, *Hoheria*, *Celmisia*, *Hymenanthera*, *Gaya*, *Plagianthus*, *Fuchsia*, *Muehlenbeckia*, *Calystegia*, *Notospartium*, *Acaena*, *Rubus*, *Clematis*, *Leptospermum*, and *Coprosma*. Small seeds should be covered with very little soil. Seeds are much better sown in boxes or pots than in the soil of the open border. The soil in which they are sown should consist of 50 per cent. or more of coarse sand.

So far as a school-garden is concerned, it is quite out of the question to draw up any general scheme. Everything depends upon the situation of the school, the enthusiasm of the master, and, above all, on the interest of the scholars. Perhaps one rather narrow bed alongside a fence, and out of the way of damage during the play-hour, would in many instances meet the case. In other places certain corners here and there would possess special advantages. The ground should be dug deeply and the drainage be good. Every plant should be labelled distinctly but not obtrusively. As well as the name, the place where the plant was collected should be noted. Labels may be made of some durable wood (totara, for instance), zinc,* or iron. As for the plants to be cultivated, that also will depend upon teachers and pupils. At any rate, it is better to grow a few well than to have many neglected.

The following plants are easy of cultivation and not difficult to procure :—

Trees. —*Sophora grandiflora*, *S. microphylla* (kowhai) ; *Plagianthus betulinus* (ribbonwood) ; *Gaya Lyallii*, *G. ribifolia* (mountain-ribbonwood) ; *Hoheria* (any of the species), (lacebark) ; *Griselinia littoralis* (broadleaf), *G. lucida*, where hardy ; *Pseudopanax crassifolium*, *P. chathamica* (lancewood) ; *Phyllocladus trichomanoides* (tanekaha, celery-top pine) ; *Nothopanax arboreum* (ivy-tree) ; *Meryta Sinclairii* (puka), where hardy ; *Metrosideros tomentosa* (pohutukawa), where hardy ; *Agathis australis* (kauri) ; *Corynocarpus laevigata* (karaka), where hardy ; *Vitex lucens* (puriri), where hardy ; *Pennantia corymbosa* (kaikomako) ; *Pittosporum Ralphii*, *P. eugenioides* (tarata), *P. tenuifolium* (tawhiri), *P. crassifolium* ; *Brachyglottis repanda* (rangiora), where hardy ; *Phebalium nudum* ; *Leptospermum ericoides* (tree-manuka) ; *Myoporum laetum* (ngaio), where hardy ; *Olearia Traversii*

* Zinc labels can be easily written upon, using as ink a solution of sulphate of copper.

(Chatham Island akeake); *Cordyline australis* (palm-lily); *Nothofagus fusca*, *N. cliffortioides*, *N. Solandri* (native beeches).

Shrubs.—A selection of distinct veronicas—*e.g.*, *V. Traversii*, *V. Dieffenbachii*, *V. buxifolia*, *V. elliptica*, *V. anomala*, *V. cupressoides*, *V. Lavaudiana*, *V. Hulkeana*, *V. pinguifolia*, *V. Hectori*, *V. salicifolia*, *V. macrocarpa*, *V. diosmaefolia*, *V. chathamica*, *V. decumbens*. Any of the taller-growing veronicas, if they become too big, can be cut out altogether and replaced by young plants grown from cuttings. There should be a selection of olearias—*e.g.*, *O. nitida*, *O. avicenniaefolia*, *O. virgata*, *O. ilicifolia*, *O. Solandri*; in fact, almost any can easily be grown except *O. semidentata*, *O. angustifolia*, and others of that class, and even these grow well in south Otago, Westland, and Southland. Most senecios are easy to cultivate, and are very showy when in full bloom—*e.g.*, *S. compactus*, *S. perdicioides*, *S. Greyii*, *S. laxifolius*, *S. Monroi*. Other shrubs easy of cultivation are the carmichaelias (native brooms), *Notospartium Carmichaeliae* (pink broom), the cassinias, many of the coprosmas, *Melicope simplex*, *Myrtus bullata*, *M. obcordata*, *M. pedunculata*.

Lianes.—The various species of *Rubus* are interesting plants. *R. australis*, with its great mass of white blossoms, is handsome when in bloom; *R. schmidelioides* goes through a juvenile and adult form, the former having much thinner leaves, and occurring usually on the forest-floor; and *R. cissoides* var. *pauperatus* makes a pretty bush, partly owing to its yellow prickles, and has a very curious appearance, with its leaves reduced to midribs. Then there is *Senecio sciadophilus* (the climbing-groundsel), and the various species of clematis.

Ferns.—Here, again, it all depends upon the climate of the proposed garden. In many parts of the North Island (the Manawatu, Taranaki, and parts of Auckland), tree-ferns, especially the black tree-fern (*Cyathea medullaris*), thrive splendidly in the open, and a grove of these may be made a striking feature. But in many districts the most shaded positions alone must be chosen, or even a special structure would need building for the ferns to thrive. The following are some of the most easily grown species: *Cyathea medullaris*, *C. dealbata* (silver tree-fern), *Dicksonia squarrosa*, *D. fibrosa*, *Asplenium bulbiferum*, *A. lucidum*, *Polystichum vestitum*, *P. Richardi*, *Adiantum affine*, *Hypolepis tenuifolium*, *Pteris incisa*, *P. scaberula*, *Blechnum fluviatile*, *B. capense*, *B. discolor*, *Polypodium pennigerum*, *P. Billardieri*, *P. serpens*, *Nephrodium hispidum*, *Pellaea rotundifolia*.

Alpine Plants.

Perhaps a formal rockery, or a special alpine garden, may seem altogether too ambitious for a school-garden. Still, the New Zealand mountain-plants yield such instructive material for study, and are so beautiful or curious, that a few, at any rate, should be grown ; and there is usually some shady corner that might be spared for these plants. Also, a good deal can be done in the way of providing a suitable growing-place by the aid of a few bricks or stones, especially if there be an abundant water-supply.

Of all forms of flower-gardening, this growing of alpine plants is the most fascinating. During recent years the alpine garden has become firmly established in Europe as an indispensable part of any garden of note. In scientific establishments, too, the cultivation of alpine plants is pursued with vigour. The new Botanic Gardens of Berlin have a great rockery, arranged on plant-geographical principles, to represent the different alpine floras of Europe. Some day, when we in New Zealand have what we ought to possess, a national botanic garden, it may there be possible to reproduce the different plant societies of New Zealand. The Royal Botanic Gardens of Edinburgh have the finest collection of alpine plants in Britain, and are specially rich in New Zealand species. Many of the Continental universities have their alpine gardens high in the Alps, where the effect of an alpine climate on the form and structure of plants can be studied.*

As for growing New Zealand alpine plants, the method entirely depends upon the climate of the locality. At Invercargill, in many parts of Dunedin and its environs, on the west coast of the South Island, and probably at many places in the interior of the North Island, alpine plants can be grown with the greatest ease in the ordinary flower-border, any special construction, such as a rockery, being quite superfluous for many species. But in some parts of New Zealand, and in certain soils, it is quite otherwise. The grand secret of growing New Zealand " alpines " is to give them perfect drainage, a shady but quite open position, and plenty of water. Where the drainage is absolutely perfect, it is hardly possible to overdo the watering

*A garden of this kind is being established at the Cass, in the mountains of Canterbury, by Canterbury College (New Zealand University).

FIG. 68.—Alpine Vegetation of Tongariro. *Gentiana bellidifolia* in bloom. A natural Rock-garden.
[Photo, L. Cockayne.
Lands Department.]

in a dry climate. In a wet one the natural rainfall may be enough. To procure this good drainage, in many cases a rockery is useful (fig. 68). It is also a fact that some few plants which root deeply love to press their roots far between the stones; and, finally, a raised bed is advantageous for displaying the smaller plants. As for the rock, some kind that will crumble with the weather is the best; but bricks are far from being a bad substitute, although an ugly one. As well as stone, there must be plenty of light soil. Sweet, peaty soil is good; a foundation of small stones is also excellent. Each individual

FIG. 69.—*Viola Cunninghamii*, the common New Zealand Violet.
[Photo, J. Crosby-Smith.

plant should be allowed a fair proportion of soil. Small shrubs, planted here and there, are effective, giving both a natural appearance and affording shelter. In eastern Canterbury the nor'-wester is the bane of the alpine gardener. The sou'-wester does little harm, but the constant east wind is better blocked out.

With management, nearly all the New Zealand alpine plants can be grown; but some are difficult to manage, even in the most favourable gardens. The following are some of the easier-grown of the

FIG. 70.—*Cotula pyrethrifolia*, growing on a shingle-slip. Southern Alps. Westland. [Photo, L. Cockayne.

herbaceous plants : *Ranunculus insignis*, *R. lobulatus*, *R. Enysii*, *Viola Cunninghamii* (fig. 69), *Oxalis magellanica*, *Geum parviflorum*, *Epilobium gracilipes*, *Myosotis australis*, *M. decora*, *Cotula pyrethrifolia* (fig. 70), *Raoulia australis*, *R. tenuicaulis*, *R. subsericea*, *Acaena microphylla*, *A. glabra*, *Ourisia macrophylla*, *Celmisia verbascifolia*, *C. rigida*, *C. Lindsayi*, *C. Mackaui*, *C. coriacea*, *C. spectabilis*, *Angelica Gingidium*, *Brachycome Sinclairii*, *Helichrysum bellidioides*, *Gnaphalium trinerve*. The following are small, shrubby plants : *Carmichaelia nana*, *C. Monroi*, *Veronica epacridea*, *V. loganioides*, *Rubus parvus*, *Veronica Gibbsii*, *Coprosma repens*.

Any of the taller subalpine scrub plants can be used, and can be replaced by smaller specimens when they get too big. In fact, the plants to be made use of will depend so much on the size and situation of the alpine garden that hints regarding what to grow are not of much use. Moreover, the enthusiastic collector will bring home all sorts of plants, regardless of their capabilities, and the success of the alpine garden will be due entirely to his own energy, and to the knowledge he will acquire in the school of experience.

APPENDIX.

DIFFERENCES IN NOMENCLATURE OF SPECIES AS CITED IN THIS BOOK AND IN CHEESEMAN'S "MANUAL OF THE NEW ZEALAND FLORA."

Name as in "New Zealand Plants and their Story."	Name as in Cheeseman's "Manual of the New Zealand Flora."
Aciphylla antipoda.	Ligusticum antipodum.
,, carnosula.	,, carnosulum.
,, latifolia.	,, latifolium.
Agropyron repens.†	Agropyrum repens.
,, scabrum.	,, scabrum.
Ammophila arenaria.†	Ammophila arundinacea.
Asplenium adiantoides.*†	Asplenium falcatum.
Blechnum capense.	Lomaria capensis.
,, discolor.	,, discolor.
,, durum.	,, dura.
,, filiforme.	,, filiformis.
,, fluviatile.	,, fluviatilis.
,, Fraseri.	,, Fraseri.
Bromus hordeaceus.†	Bromus mollis.
Cassinia albida.	Cassinia Vauvilliersii *var.* albida.
Crassula moschata.	Tillaea moschata.
Danthonia antarctica.*†	Danthonia bromoides.
,, flavescens.	,, Raoulii *var.* flavescens.
Dracophyllum arboreum.	Dracophyllum scoparium *var.* major.
Epilobium erectum.	Epilobium junceum *var.* macrophyllum.
Gaya ribifolia.	Gaya Lyallii *var.* ribifolia.
Hoheria angustifolia.	Hoheria populnea *var.* angustifolia.
,, sexstylosa.	,, lanceolata.
Lagenophora pumila.*†	Lagenophora Forsteri.
Luzuriaga marginata.†	Enargea marginata.
Macropiper excelsum.	Piper excelsum.
Myriophyllum Votschii.	Myriophyllum pedunculatum (*in part*).
Nothofagus cliffortioides.	Fagus cliffortioides.
,, fusca.	,, fusca.

* Change recognised by Cheeseman since the publication of Manual.
† Change in accordance with the International Rules of Botanical Nomenclature of 1906.

DIFFERENCES IN NOMENCLATURE—*continued.*

Name as in "New Zealand Plants and their Story."	Name as in Cheeseman's "Manual of the New Zealand Flora."
Nothofagus Menziesii.	Fagus Menziesii.
,, Solandri.	,, Solandri.
Nothopanax anomalum.	Panax anomalum.
,, arboreum.	,, arboreum.
Olearia cymbifolia.*	Olearia nummularifolia *var.* cymbifolia.
Paratrophis opaca.†	Paratrophis Banksii.
Plagianthus chathamicus.	Plagianthus betulinus.
Plantago carnosa (?).	Plantago Brownii.
Polystichum Richardi.	Aspidium Richardi.
,, vestitum.	,, aculeatum *var.* vestitum.
Pteridium esculentum.	Pteris aquilina *var.* esculenta.
Ranunculus lobulatus.	Ranunculus insignis *var.* lobulatus.
,, multiscapus.	,, lappaceus *var.* multiscapus.
Rapanea Urvillei.	Myrsine Urvillei.
Senecio scorzoncrioides.	Senecio Lyallii *var.* scorzonerioides.
Silene anglica.†	Silene gallica.
Sophora grandiflora.	Sophora tetraptera *var.* grandiflora.
,, microphylla.	,, microphylla.
,, prostrata.	,, prostrata.
Styphelia acerosa.	Cyathodes acerosa.
,, fasciculata.	Leucopogon fasciculata.
,, Richei.	,, Richei.
,, robusta.	Cyathodes robusta.
Tetrapathaea australis.	Passiflora tetrandra.
Veronica buxifolia *var.* odora.	Veronica buxifolia *var.* patens.
,, gigantea.	,, salicifolia *var.* gigantea.
,, glaucophylla.	*Considered synonymous with* Veronica Darwiniana.

* Change recognised by Cheeseman since the publication of Manual.
† Change in accordance with the International Rules of Botanical Nomenclature of 1906.

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